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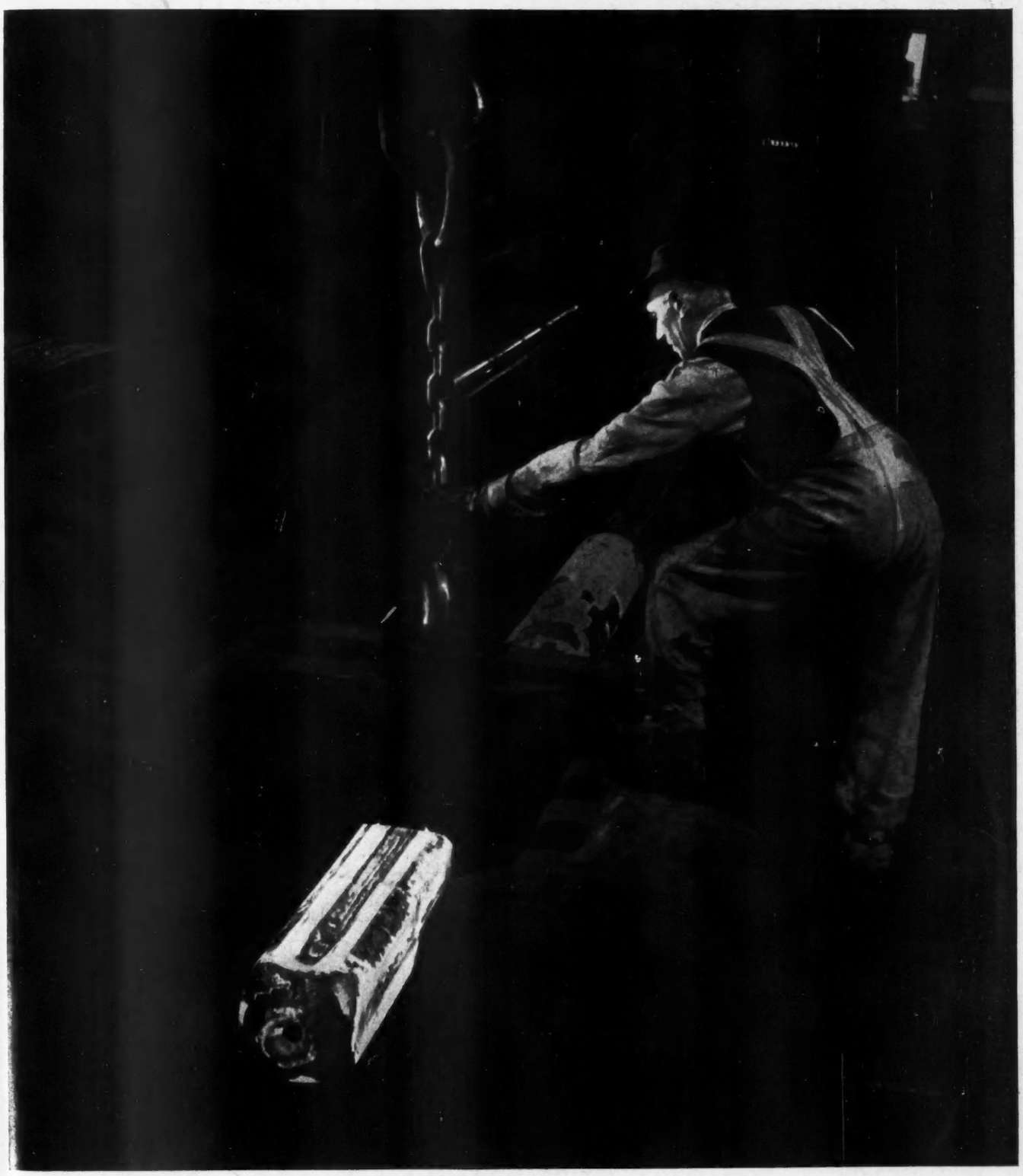

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The lower illustration shows the welding of supporting lugs for superheater control dampers.

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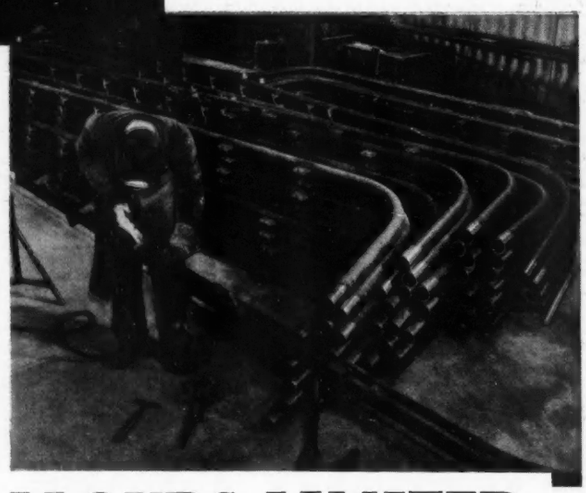

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HONOURING DELIVERY DATES

GENESIS is not explicit about the time God allowed Noah for building the Ark, but we know that when the flood came Noah and his family, the beasts and fowl were able to go in. Noah had completed his work on time. Though no one since has had such good reason for abiding by the delivery date, in engineering to-day it is one of the most important clauses of a contract. As there is hardly an engineering firm that is not both customer and supplier—and therefore conscious of the folly and annoyance of a failure to adhere to that part of the contract—it is worth examining the wider implications of delivery dates, thereby discovering, perhaps, that they are bound up with the whole condition of industry and that their importance to a firm and all its employees needs to be more generally and sincerely understood.

When a big contract is not completed on time the world soon knows about it, usually because a Government minister chooses to make a public complaint. It is a pity good news does not travel as quickly as bad news, because sometimes contracts are completed well before time, often to the considerable profit of the customer. (We would be glad to hear of cases of this kind if anyone cares to write and tell us about them, because a little publicity in this direction might help to offset the damage that is done by the complaints). It would be easy, of course, to insure against non-compliance with a delivery date by allowing ample time to complete the work. But present conditions do not permit such an easy way. The customer usually specifies the date, and the contractor must either agree to it or decline the work—or at best quote the earliest date to which he can work. It is therefore vital to be able to make an accurate estimate of future output capabilities. Everyone in the firm is involved in these estimates. If labour troubles or any kind of negligence should delay production, the loss is likely to be felt by all employees and, in the long run, by the nation. Production plans that are too optimistic place a heavy premium on these dangers, and at the other extreme too much caution may lead to the loss of work that could have been undertaken. The management should be able to rely on adherence to a realistic schedule.

The customer, too, has to bear his share of responsibility. He ought to look ahead, and plan well in advance so that the supplier or contractor has a fair chance. This can be very difficult because so often, when a plan has been made, there is a desire to see it implemented as soon as possible. Thus the supplier, who is only too familiar with the impatience of his customers, tries to make a difficult forecast: he tries to see farther than they themselves can see. This may be reasonably possible for a tool-maker who supplies ironmongers, but in general the closer one comes to the basic industries the more difficult it is. The demand on these industries is the resultant of the whole polygon of forces in the national economy. The steel industry, for example, has to plan very far ahead; the capital involved is prodigious and the time scale is large. Yet the slightest failure of the steel industry to meet the need for its products can react violently on industry, just as an express train running late can upset the timing of innumerable trains for many hours. It is fortunate for this country that its steel industry has such an excellent record of labour relations, for disputes in the basic industries have an effect far beyond their immediate circumstances.

After the war there was a lurking feeling that the experience of the early 1920's might be repeated. There was a natural inclination to take on all the work that was offered, with the result that contract dates were not always kept. Deliveries were becoming more reasonable when the Korean War upset the pattern and imposed unexpected delays. By 1953 conditions were more normal. By 1954 orders and capacity were nicely balanced. This year, however, the curve of delivery times has been steadily rising. Deliveries now commonly run to eight or nine months for quite standard items, or even as far ahead as 1957 for supplies to, for example, the building industry, which has been grossly overloaded for some time.

The cause of the delays is different in different areas. In the Midlands it is a shortage of labour; in some other areas it is a shortage of steel. Fundamentally, the delays arise from the general economic state of the country, which is, paradoxically, too vigorous to be healthy. We are trying to do too much too quickly; or, to express the same idea rather bluntly, managements and the Government are planning more work than workers are able or willing to do. It remains to be seen how these conditions will be resolved during the coming months. Whatever happens the important thing is that any change in conditions should not take place suddenly. A gradual improvement, leading to a steady reduction in delivery times, is to be looked for, because full employment is a condition of unstable equilibrium which it would be easy to upset. The surest way to effect an improvement would be to campaign for shorter delivery times, and for a general acceptance of the need always to honour delivery dates.

Weekly Survey

Cover Picture: *To make a power-station boiler superheater header, a thick-walled steel tube, having one end almost closed in, is heated to about 1,150 deg. C., and threaded on to a square-section draw bar secured to the moving cross-head of a hydraulic draw bench. On pushing the tube through two special dies the circular shape is changed to a square one. Finally, the tube is removed from the bar by placing a horseshoe-shaped stripper behind the end of the header and backing up against the last die. On reversing the machine, the draw bar is drawn out of the now square-section header.*

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Production Enigma

Resilient industrial output in the third quarter of this year owes a great deal to the growing production of the metal and engineering industries. According to the official index of production, output in September was provisionally 4 per cent. higher than in September last year. Comparing the first quarter of this year with the first quarter of last year, the manufacturing industries raised their output by 8 per cent. compared with 6·1 per cent. over 1953. In the second quarter the increase was 7 per cent. compared with 5·7 per cent. It would appear therefore that when the full figures are available for the third quarter, a substantial increase in production will be found to have taken place in the first three quarters of this year compared with the same period of last year, although the rate of increase may have slackened over the year.

Outstanding progress has been recorded by the steel industry, by engineering and by chemicals. In the engineering industry the output of vehicles has been particularly buoyant, and this in itself transmits a high level of activity to a wide range of component manufacturers. The two industries which have lagged behind this year have been coalmining and building. Although coalmining may improve as Christmas approaches, the autumn Budget is not likely to stimulate the building industry once present orders have been worked off.

Earlier this year it appeared that the boom which has so exercised the Government of recent months was being built up by a rapid expansion in consumer goods industries (notably in consumer durable goods) and in capital goods. It may well be that when the final September production figures are available, they will show that the boom in consumer goods was already past its peak by September and that the impetus is being provided mainly by capital goods. If this should be so the autumn Budget will have been found to accelerate a trend which has already begun. Indeed, provided a general deflationary climate does not set in, the immediate outlook for the engineering industry remains good for there is nothing in the Budget of itself which should reduce orders for capital equipment sufficiently to force the engineering industry to operate below full capacity.

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Educating the Schools

Young scientists, mathematicians and engineers (except the genius) are not born. They are made. Made—that is, educated—in the schools, and if industry is to have an adequate supply of well-trained technologists the schools must give a sufficient number of young people a good grounding in the basic sciences. There can be nothing but approval for the sponsors of industry's new educational trust which, as reported elsewhere in this issue, has been formed by 17 leading companies, mostly engineering firms. This trust, for which £1½ million have already been guaranteed and which will surely receive much further help, is designed to assist those schools that depend wholly or in part on private endowments. These include the recognised public schools and many of the old city and town grammar schools that have for so long been the traditional sources of talent.

The monies, to be applied by a distinguished committee, that includes so many men well known to engineers, will be used for building and improving laboratories and science facilities at the chosen schools. The existence of well-equipped laboratories should certainly achieve two objectives: direct a higher proportion of the young people into the science side and, most important, attract more scientists to teaching. Although the fund will not be used for improving salaries, there are many who would be attracted by a good laboratory and—as the particular schools concerned should be able to provide—a freedom to develop a piece of personal research as well as to teach, a practice so far restricted to the better universities. The increase in the school science population must serve ultimately to give industry a larger number of recruits, quite apart from the effects of other schemes of recruitment that may be afoot.

Despite the propaganda of recent years, headmasters and teachers have been slow to appreciate the genuine and worthwhile openings that there are in industry for their science scholars and embryo engineers. The excellent and generous approach that has been made by industry, receiving as it did widespread commendations in the Press and on the B.B.C., will have done much to remedy the teachers' false conception of the narrowness of industry—and of industrialists.

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Two Views on Shipbuilding

Although shipbuilding is booming, the reactions of shipbuilders to the seemingly bright outlook is by no means uniform. Sir John E. Thornycroft, in his recent chairman's speech, struck a dissonant note when he warned shareholders of the problems which have arisen due to undermanning. This, he stated, is limiting output and keeping up costs, which, in the face of growing competition in the export market for ships, may make the boom short-lived. John I. Thornycroft and Company, Limited, have had a successful year, but in the shipbuilding field they are meeting difficulties due to this problem of shortage of workers, though this may be due to the company's location in Southampton and is unlikely to be the general experience of other shipbuilders.

Dr. E. P. Andreae struck a rather more confident note in his report to the annual general meeting of William Doxford and Sons, Limited. He stated that the demand for all types of ships had increased enormously since last year and orders are now booked which will "enable the yard to work to full capacity for at least five years ahead." Investment has obviously played a big part in Doxford's success. They have spent over £2 million in the last ten years in modernising and extending plant and equipment and claim that they have a shipyard capable of producing ships as economically as any other establishment in the country. It is to this increased investment that the industry as a whole must look if the boom is to last. Although it is predicted that the industry's order books this year will exceed 5 million tons gross for the first time since 1951, the increase in output will probably involve a rise in the labour force or increased investment. If the shipbuilding industry is going to satisfy all the demands at present made upon it, a greater measure of investment and modernisation must be forthcoming. It is now, while demand is outstripping production, that this investment should take place.

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Social Adjustment to Technological Change

There is a growing awareness of the problems of adjustment for societies with traditional social structures faced with rapid technological change. The urgency of the problems has been accentuated by the demands of the peoples of underdeveloped countries for higher standards of living, which are only possible on the basis of industrialisation. A valuable contribution to the study of these problems is being made by the Social Science Department of Unesco. The department operates by stimulating national research bodies to undertake new work, and co-ordinating their findings and methods; by getting new work of a pilot character undertaken under contract; by holding conferences of scientists and administrators; and by assisting member states to meet specific needs.

An international research office on the social implications of technological change was set up in 1953. It arranged a round-table discussion last year on the comparative study of economic motivations and incentives in underdeveloped countries, the findings of which were published in the International Social Science Bulletin. A research centre on the social implications of industrialisation in South Asia will be set up in India in 1956. Last year an important conference of social scientists and administrators was held at Abidjan on the social impact of industrialisation and urban condition in Africa, based mainly on a field study conducted in the Belgian Congo. The conference discussed the adaptation of Africans to industrial life, including the acceptance of Western technical methods and values, relations between urban and rural populations, and family relations and community life in opposition to structures in the new African urban populations.

In 1952 a report on "Education in a Technological Society" was published which dealt with the technical education suitable for preparing students to take part in rapid technological progress. A request was recently received from Brazil for assistance in a survey to provide the data and social analysis necessary for a reorientation of the Brazilian educational system. The object of this far-reaching project is to relate education to the needs of a country undergoing economic development and social change.

The value of work of this kind depends on the integrity of the research workers engaged on it, the degree of independence with which it can be carried out and the freedom with which the results can be published. In an international body of this kind there are obvious dangers if, for reasons of national policy or prestige, these conditions may be infringed. It is to be hoped that the states which are members of Unesco will be sufficiently convinced of the value of this work not to impede in any way the scientific independence either of those who administer it in Paris or those who make the inquiries in the field.

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Expansion of Thos. W. Ward, Ltd.

The acquisition of subsidiary companies has been one of the outstanding features of the financial year for Thos. W. Ward Limited which ended in June last. The company spent £1·1 million on this activity during the year. The capital employed in the group had reached almost £10·7 million by the end of the 1955 financial year and this is a new level on a figure which has been growing steadily for a number of years. Turnover of the group increased on the year by 19 per cent. to £36·6 million, a record level. The turnover of the parent company has not yet passed the record achieved in 1953, but at £21·3 million it was more than 4 per cent. above last year's level. It is significant that a company as well established and prosperous as Thos. W. Ward should absorb its energies not only in expanding the activities of the Ward Group at any one time, but of rapidly widening its interests as well. It may be that a long period of prosperity for the engineering industry will cause an increased concentration of control in large groups which can put up the capital for development in an age when a strenuous effort is being made to increase the capital employed per worker, capital which is not only highly productive but exceedingly expensive as well. To-day, the Ward Group comprises 26 subsidiary companies in addition to Thos. W. Ward itself.

The parent company's activity has been closely linked with the high prosperity of the steel

industry. The company's total deliveries of scrap iron and steel, excluding imports, have been at a record level. Significantly, production tonnage in ship-breaking has fallen as freight rates have increased, thus making old tonnage more remunerative to keep in service. The chairman, Mr. H. W. Secker, points out that physical volume of turnover of the parent company is only slightly above last year's figure owing to the increase in prices. Trading conditions overseas have not been easy and turnover has been kept up by reducing profit margins, particularly in European markets. The outlook is good in the chairman's opinion, provided that the Chancellor's measures do not result in too drastic a reduction in credit and capital expenditure.

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Impact of Norwegian Steel

Full details of the new steelworks at Mo i Rana, operated by A/S Norsk Jernverk just below the Arctic Circle in Norway, have become available in the last few weeks. A certain amount of controversy developed round this plant, since it took longer to build and cost more than was originally anticipated, the controversy being complicated by the fact that the Mo i Rana works is a Government project and therefore has constant political implications in Norway. The basic reason for installing this steelworks, which is completely integrated from raw material to finished steel product, was the fact that Norway imports about 500,000 tons of steel a year and has economical iron-ore deposits and cheap hydro-electric power. To begin with, Mo i Rana is making about 170,000 tons of hot-rolled steel a year, which is about 34 per cent. of total consumption. This will be a valuable saving in foreign currency.

The issue, however, is not quite as simple as this, for to be economical the new works must operate on a large scale, whereas Norway's demands for steel are fairly highly diversified both in sizes and qualities. Norway must therefore export some of its steel to get economic production. In the first stage, the range of output is blooms, slabs, billets, sheet, bars, heavy and light sections, merchants' bars, concrete reinforcing bars, wire rods, hoops and strips. It is known that the company is considering the possibility of installing a seamless steel tube mill of 60,000 tons capacity which would also have to export part of its output if it were built. So long as the demand for steel products is buoyant the absorption of, say, 250,000 tons of additional finished steel on the world market presents no problem. If, however, there were to be a serious recession in steel activity the position would become very interesting. A new steelworks would exist which it would not be easy to fit into a cartel, and although the present policy of the European steel industry (including that in the United Kingdom) is expansionist, it might become distinctly cartel-minded in a recession and try to fix production quotas on a base period. How would a new steelworks with no traditional connections with the rest of the European steel industry, and possibly no base period on which to calculate a quota, fit into such a system?

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More Steel Alloy and Plate

Recent schemes announced by the United Steel Companies Limited, and developments at Colvilles Limited, suggest that at least part of the steel industry is accelerating its plans to assist the increase in output of certain sections of the engineering industry. Since 1948 the United Steel group has spent £44 million on expansion and modernisation and intends to spend another £25 million in the next three or four years—a rate of expansion which is in line with that planned by the steel industry as a whole.

The most recent development in the group's plans was the announcement last week by Samuel Fox and Company, Limited, of their intention to expend a further £2·8 million on installing, by 1957, a second large electric furnace together with extensive modernisation of the billet rolling mill at their Stocksbridge works. Construction work on the new £2·4 million rod and bar mill, plans for which were announced in July this year, has already begun, while the latest scheme makes provision at some future date for the erection of an additional mill and for the extension of a new bar-treatment plant should these developments be required. At present, the plans will result in a substantial increase in tonnage of special and alloy steels used in the motor industry, in chemical plant, civil aircraft, and so on.

Though the actual tonnage of ships completed in British yards so far this year is slightly lower than in 1954, the recent sharp rise in tanker and dry cargo orders indicates a boom in shipbuilding which will necessitate a greatly increased production of steel plate. October 31 saw the end of the first year's construction work at Colville's new iron and steel plant at Ravenscraig, near Motherwell. Work is at present two months ahead of schedule in this £20 million development scheme, which comprises the erection of complete coke, iron and steel making facilities. The new works will supply steel ingots to the recently modernised rolling mills in the group's adjacent works and is designed primarily to reduce dependence on imported scrap. These increased by 60 per cent. for the industry as a whole during the first eight months of the year. When completed in the autumn of 1957, the plant will be producing 350,000 tons of pig iron and 400,000 tons of ingot steel, thus raising the annual output of the Colville Group to about 2¼ million tons. This total, which means an annual increase of some 6½ per cent. in steel ingot production, is in line with the Steel Board's plan, which envisages a 6 per cent. rate of increase in annual output up to 1958.

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Small Companies at Work

This is still a country of small businesses no matter how apparent the trend may be towards integration into large combines. Remarkably little is known about the case history of these thousands of small concerns. Too often the impact of technical and economic change on the industrial community is assessed in terms of their effects on large organisations only.

The Oxford University Institute of Statistics undertook a pilot survey of a sample of private limited companies in the Birmingham area early this year and the results are published in the latest bulletin of the Institute. The survey may not be representative in a scientific sense but the results published so far on the returns obtained give some information on the circumstances in which such concerns operate. In due course, the Institute will be producing a more detailed analysis of the assets and liabilities of these businesses. Many of the firms are long established; of 85, nearly 50 per cent. were established before 1900, over a quarter before 1875 and nearly an eighth before 1850. By contrast, nearly an eighth have been founded since the recent war. There is thus both a high longevity rate and a high rate of entry. Two-fifths of the concerns were completely owned by families, and in three-quarters of them the family held a major interest. (This is not a surprising result in the Birmingham area and might be less apparent elsewhere.) As would be expected, most concerns had a simple management structure and half of them employed fewer than 50 workpeople, this last notably among younger firms. A high proportion of the sample were subcontractors to other manufacturers. The main source of finance has been ploughed-back profits, loans from directors, and bank overdrafts.

There were signs in the sample that profits were high enough to satisfy the owners but not always high enough to attract outside capital. Indeed there was little sign of an effort to find finance in a period of expansion of trade in order to increase the profitability of companies. On the other hand, there was no sign that such concerns have been starved of capital. If one were to essay some tentative conclusions on this survey they would be as follow. Small businesses are often dissuaded from expanding because their owners have no incentive to raise their incomes above a certain level. The impact of death duties, however, may force such concerns increasingly to look elsewhere for capital and there is likely to be an increasing pressure on them to sell out for capital sums as time goes on. There is little sign that the famous " Macmillan Gap " of the 1930's any longer exists to starve small companies of capital. There are two main dangers. First, the impact of death duties and high income tax may make small companies less enterprising and may result in their losing experienced owners too soon. Secondly, too many small companies may be forced into the position of becoming subcontractors to large public companies whose bargaining power may so reduce the profitability of small concerns that new ideas are increasingly difficult to put on a commercial footing.

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Nuclear Power Factor

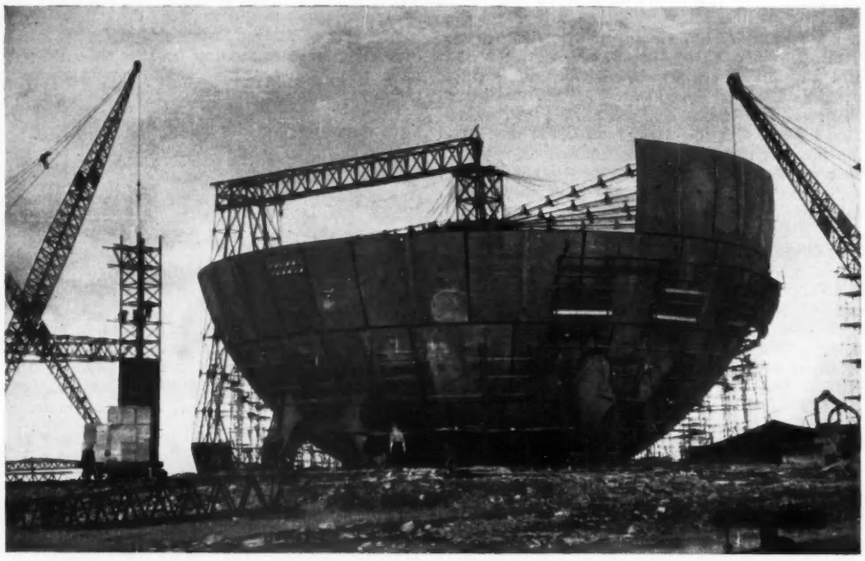
Three factors are essential to the success of any engineering project : men, money and materials. The first annual report of the United Kingdom Atomic Energy Authority—summarised on page 652 of this issue—reveals that Britain's atomic power programme has not suffered, nor is likely to suffer, from lack of the last two. But the shortage of skilled men, both engineers and senior staff, is a more serious consideration; it may prove to be the limiting factor in Britain's nuclear development.

At a Press conference held to announce publication of the report, Sir Christopher Hinton drew attention in particular to the Authority's need for engineers; all programme dates had been, and would be met, but this involved great strain and the nuclear power programme could be more ambitious if the staffing problem did not exist. Industry's contribution to the programme had been vast but it could not be denied that the Authority and industry were in competition for qualified men. Sir John Cockcroft did not believe that there was a serious leakage of scientists and technologists to America; the shortage rose rather from a general deficit of scientific manpower throughout the country. Sir Edwin Plowden, however, agreed with a questioner that the Authority did not have the same freedom as industry in engaging men, since it was dependent on public funds ; salaries did not differ from those in the remainder of the scientific Civil Service.

But in spite of these difficulties, the Authority has made excellent progress. In 1957 the benefits of the Calder Hall station will begin to be felt and soon much larger burn-ups of nuclear fuel will be achieved in reactors to be used in our civil programme, thus giving much greater fuel economy. Sir John Cockcroft said that, although the life of the power stations now building was estimated at 15 years, it was his guess that they would last much longer. Sir Christopher Hinton, on being asked if the omission from the United States programme of gas-cooled graphite-moderated reactors had any significance for us, replied forcefully that he considered the gas-cooled reactor an excellent thing. " You would not imitate a competitor you thought to be wrong," he said. In many ways, Britain is in advance of the United States; almost certainly we shall be the first country to have a working nuclear power station of any size.

In addition other projects are proceeding. With regard to ship propulsion, the Admiralty have been performing investigations in collaboration with the Atomic Energy Research Establishment, and are about to enter the design stage ; while the use of nuclear reactors in merchant ships is being examined at Harwell by a team from the British Shipbuilding Research Association.

But if the greatest benefit is to be derived from this work, and the work itself extended, then more trained men and senior staff must be found. These men cannot be expected to come forward from purely altruistic motives.



Work is proceeding rapidly on the construction of the experimental fast breeder reactor at Dounreay, in Caithness. It is to be housed in a steel sphere, 135 ft. in diameter, which is shown approaching the half-way stage. When completed, the reactor will produce power for the National Grid, and will create more nuclear fuel than it consumes.

A YEAR OF NUCLEAR PROGRESS

FIRST ANNUAL REPORT OF UNITED KINGDOM ATOMIC ENERGY AUTHORITY

A year of substantial practical and experimental progress is recorded in the first annual report of the United Kingdom Atomic Energy Authority. The report, which has recently been made public, covers the period July 19, 1954, to March 31, 1955, and deals with most aspects of the Authority's work, from the procurement and concentration of radioactive materials to the development and construction of power-producing and research reactors, and from health and safety considerations to the preparation and use of radioactive isotopes. Finance, organisation and staffing are other aspects dealt with, and attention is specially drawn to the Authority's need for skilled manpower, particularly for engineers and senior staff. It is also reported that the erection of the fast breeder reactor at Dounreay is proceeding, and that a number of new reactor studies have been undertaken by the Atomic Energy Research Establishment; certain of these are concerned with homogeneous and slurry systems. LEO (Low Enrichment Ordinary Water), a detailed design study for reactors using light water as moderator, is also yielding valuable information. Parts of the report are summarised below; where subjects have previously been treated in ENGINEERING, references to the appropriate articles are given in brackets.

THE THREE MOST NOTABLE EVENTS

The three most notable events recorded in the report were: first, the formation of the Authority itself; second, the publication last February of the Government's White Paper, *A Programme of Nuclear Power* (ENGINEERING, vol. 179, page 240, 1955); and thirdly the Government's decision to proceed with the development and production of thermo-nuclear weapons. Other features of the period were collaboration with scientists and technologists abroad and the growth of public interest in atomic energy.

Although the report is the first to be published by the U.K.A.E.A., this does not indicate that the organisation is without previous experience and achievement. In fact many of the present staff were members of the parent establishment before the Government decided to transfer atomic energy matters from the Ministry of Supply to a non-departmental body, and had contributed extensively to its success. The Authority came into being on July 19, 1954, under the provisions of the Atomic Energy Authority Act. The Government's decision to take this step was based on the belief that with the growing prominence of the industrial uses of atomic energy, the case for a form of control more akin to the structure of a large industrial organisation than to that of a Government department had become very strong. It would moreover become stronger as the need for closer contact and co-operation with industry developed.

SHORTAGE OF SKILLED MANPOWER

The Authority differs from other nationalised undertakings in that it depends for its funds on money voted by Parliament. The estimate for the financial year 1954-55 gave a net total of £53,675,000; and an estimate for 1955-56 showed that a sum of £50,562,000 would be required. Other general subjects mentioned in the report were the construction of a new outstation at Bracknell in Berkshire, which when completed will serve as a general workshop for the Atomic Energy Research Establishment; the opening of a reactor school for A.E.R.E. staff and industrial representatives in September, 1954; and the lack of qualified personnel.

The shortage has been exacerbated by the rate at which the United Kingdom atomic energy project has grown and the need to maintain a fixed timetable. In fact the only threat to the execution of this programme is the inadequate supply of skilled manpower. No Government has hesitated to furnish the money needed for buildings, plant and equipment; material shortages have never been insuperable; but the difficulty of recruitment shows no sign of abating. (ENGINEERING, July 1, page 7, 1955.)

In the report it states that the " Authority is in competition with industry (and notably with sections of industry that are themselves building up staff in order to enter the field of nuclear energy) for staff to carry out their development programmes; and, as a body dependent upon public funds, the Authority has not the same freedom of manoeuvre as industry in the matter of salaries. Its members are aware, of course, that the shortage of technological skill is nation-wide, and that steps are being taken to alleviate it. They feel it essential, however, to put this subject in the forefront of their report because the development of atomic energy is unique in the variety of specialised skills which it demands. This demand is not at present being met."

RADIOACTIVE RESOURCES

A less serious problem is the procurement of radioactive materials. In 1944, the Governments of the United Kingdom, the United States and Canada, set up an organisation to secure uranium for the joint war effort. This war-time arrangement survives, with modifications, as the Combined Development Agency, from which the British atomic energy project has so far drawn all its supplies of uranium. The Agency makes contracts for the supply of uranium, which in due course is allocated between the United States Atomic Energy Commission and the Authority according to need; Canada as an important uranium producer has no need of external supply arrangements. Other sources of uranium are: the Belgian Congo, South Africa, Australia, Portugal and British colonial territories, including Northern Rhodesia where the Nkana mine in the copperbelt has revealed a small deposit capable of economic exploitation.

The two piles at Windscale Works in Cumberland (ENGINEERING, vol. 177, page 313, 1954) have produced the planned amount of plutonium. One interesting development has been the use of a television camera, which was lowered into a part of the pile where the activity was too great to permit access, in order to investigate the conditions of the structure. Photographs were taken of the pictures on the screen and these gave the engineers a permanent record. Certain minor defects were discovered and methods are being devised to rectify them.

Of the Windscale "separation " plant, where plutonium is separated from the irradiated cartridges, the report points out: " It is noteworthy that although this plant was built on the assumption that once it had started working nobody would be able to enter it again on account of the activity, the factory staff have succeeded in devising methods of decontamination, which allow access for limited periods. This has made possible a number of modifications which have increased the capacity of the plant."

Thorium is a reasonably abundant raw material and no undue difficulty is foreseen in procuring the supplies that will be needed. (ENGINEERING, August 26, page 264, 1955).

DISTILLING HEAVY WATER

Heavy water can be distilled from natural water at an " attractive price " if there is a low-cost source of steam and if plant cost can be reduced by the development of high efficiency distillation equipment. These conditions can be fulfilled. Geothermal steam in New Zealand offers a source of low-cost steam; and experimental work at A.E.R.E. has led to the development of distillation-column packing of such high capacity that the capital cost could be substantially reduced. The new packing is known as " Spraypak."

Towards the end of 1954, an agreement was signed between the New Zealand Government and the Authority whereby a joint company, Geothermal Development, Limited, was set up with the object of building a plant at Wairakei in the geothermal region of the North Island. It is expected that the first heavy water will be produced from it towards the end of 1957.

The reactor construction programme has proceeded according to plan and the Authority expects that by 1957 the Calder Hall power station will be supplying electricity to the Central Electricity Authority (ENGINEERING, vol. 179, page 240, 1955). The Dounreay establishment, in the extreme north of Scotland, is intended to house several reactors of experimental or

advanced designs, together with the plants for fabricating their fuel elements and treating them after irradiation. The first commitment there—the construction of a fast breeder reactor—had begun by the end of March. (ENGINEERING, August 26, page 28, 1955). Part of the steel sphere, 135 ft. in diameter, in which the reactor will be housed is shown in the illustration opposite. When completed, the reactor will produce power for the National Grid and will create more atomic fuel than it consumes.

LEO

In addition to the research reactors already announced, a number of other projects are in progress at A.E.R.E., Harwell; among these are the homogeneous and slurry systems and LEO. Of the various moderators available for use in reactors, ordinary (or light) water is particularly interesting because of its cheapness and availability and because it can also serve as the coolant. A reactor of this type consists essentially of a pressure vessel to contain the water, into which are inserted, in a regular lattice array, rods of the enriched uranium fuel. These rods must be sheathed in a corrosion-resistant material in order to prevent attack on the uranium by the water, and also to prevent too much radioactivity from the fuel from entering the water. One of the main metallurgical problems is the development of this sheathing material. Stainless steel is one possibility but has the disadvantage of being a strong neutron absorbent unless it can be used as very thin-walled tubes. Another possibility is zirconium; here again there is a disadvantage, this time of cost. Other alloys are promising.

Preliminary investigations of light-water reactors began at A.E.R.E. several years ago with the examination of possible experimental systems on a small scale. This work has subsequently extended to a survey of schemes whereby power might be produced as economically as possible in units each producing 100 MW or more of electricity. Early in 1954 it was decided to proceed to the next stage of a detailed design study now known as LEO. This work is still in progress.

It is tentatively thought that it is advisable to generate saturated steam by the reactor heat and then to superheat this steam in a separate unit fired by conventional fuels. The reactor supplies about three-quarters of the total heat consumed, and this "mixed" system can achieve a thermal efficiency approaching that of modern coal-fired power stations at a reasonable capital charge per kilowatt generated. Particular attention is also being paid to simplicity of layout in order to keep all capital charges to a minimum.

The design study of LEO is being carried out at Harwell by A.E.R.E. in collaboration with the Industrial Group of the Atomic Energy Authority, Babcock and Wilcox, and the English Electric Company. A representative of the Central Electricity Authority has been acting as a consultant.

HOMOGENEOUS AND SLURRY SYSTEMS

Among the new types being studied is the homogeneous reactor. In this, the fuel is used in the form of a solution or fluid suspension, instead of solid metal rods. The solvent is the moderator and cooling is achieved by circulating the whole solution. Studies are also being carried out on liquid-metal slurry systems, in which the fissile material is dissolved, or carried in particles, in some liquid metal. Both the homogeneous and slurry systems offer a number of advantages over the solid-fuel type of reactor. Among others they dispense with the need for fabricating cartridges; and they make it possible to achieve greater utilisation of the fuel by continuous removal of fission product poisons.

The output of radioisotopes from Harwell and Amersham (ENGINEERING, vol. 177, page 630, 1954) during the year ended March 31, 1955, was 18,835 consignments, an increase of 16 per cent. over that for the calendar year 1953. Of these 35·6 per cent. was exported and the main buyers were the United States, Canada, France, Germany and Sweden; some 40 countries in all used British isotopes last year. The value of the radioactive products sold during the year under review was about £450,000.

A plant is now being built at Windscale to produce concentrated sources of caesium 137 and strontium 90 with activities in the region of 1,000 curies. The first kilocurie source of caesium 137 was sent in August this year to the Royal Marsden Hospital, London, where it will be used for radiotherapy. Within the last few months a technological irradiation unit has been established at Harwell to carry out research, and inform industry of the possibilities for using these products (ENGINEERING, vol. 179, page 782, 1955). Considerable developments in the usage of isotopes have taken place in the period. (ENGINEERING, September 2, page 292 and October 28, page 597.)

It is expected that the separation of radioactive products for these purposes will contribute to the disposal of waste materials on a large scale, but meanwhile the Authority is employing measures to deal thoroughly with radioactive waste whether in gaseous, liquid or solid form. "The precautions taken are such that there can be no conceivable hazard to human beings, agriculture or fisheries."

ACCELERATORS AND SEPARATORS

Physical research on the nature of the atomic nucleus has continued at Harwell, and to increase the facilities available for investigating the interactions of neutrons of different speeds with a variety of elements, a novel and much more powerful source of neutrons for use in the laboratory (the "neutron project") is being developed at A.E.R.E. In this apparatus the multiplying effect of a uranium target bombarded by neutrons resulting from a powerful pulsating electron beam (25 MeV at 1 ampere) is used to enable measurements to be extended and made more accurate. The first stage of a working unit is to be installed in the autumn of 1956.

Consideration is also now being given to the design of a new high-energy particle accelerator to exceed the scope of the present 110 in. synchro-cyclotron and to maintain this country in the forefront of current research. Decision as to the exact form of this accelerator awaits the result of complex calculations, but the machine most exhaustively studied has been a 600 million volt proton linear accelerator of which a 50 million volt pilot section is under construction. However, in view of recent rapid advances, the design and construction of machines of still higher energy are to be examined before proceeding further. (Accelerators are described in ENGINEERING in the current volume on pages 340, 374 and 530.)

Also of interest is a machine for separating milligram quantities of the chemically inseparable isotopes of heavy elements such as plutonium, americium and neptunium by magnetic methds. An infra-red spectrometer has been developed which permits the percentage of heavy water in light water to be continuously recorded.

The Research and Development Branch of the U.K.A.E.A. Industrial Group has dealt successfully with the development of new solvent processes for the extraction of uranium from its ores and with the application of the so-called "fluidised bed" technique to the processes used in the Industrial Group. Essentially this technique facilitates chemical reaction between a solid and a liquid or gas by using the solid in the form of a bed of finely divided particles, through which the second material is blown, and which owing to its finely divided state behaves like a fluid.

EXTRACTING METALS CHEAPLY

During the past year a new method for extracting metals using only cheap chemicals and simple equipment has been tried on a pilot scale with success. In this process the oxides of uranium, thorium or beryllium are converted to the appropriate chlorides, from which in turn the metals are extracted. By changing the conditions of reduction the metals can be obtained in the form of powders with particles of varying shape and size. This affords flexibility of fabrication and provides materials the properties of which can be modified.

ALUMINIUM ALLOY: CERAMIC FUELS

It has recently been established that an aluminium alloy can be made with useful water corrosion resistance up to 300 deg. C. for short periods (up to 200 hours), and may therefore serve as a cheaper alternative to zirconium-tin alloys in future power reactors using water as coolant. The distortion of uranium fuel elements due to irradiation and secretion of fission products has also been investigated. One of these effects is surface wrinkling, and this problem has been tackled by modifying the grain size of the metal by heat treatment or alloying.

The metallurgy of liquid fuels and slurries is also being studied. Solid fuels, however, need not be metallic, and ceramic compounds with high melting points (about 3,000 deg. C.) are of some interest. These are generally brittle and methods of making them more resistant to shock are being studied. This may be achieved by preparing cermets, that is mixtures of metals and ceramics appropriately distributed. Some interesting possibilities are uranium-thoria, silicon-uranium oxide and uranium-uranium carbide.

The application of electronics to reactor technology is illustrated by an analogue computer being developed at A.E.R.E. It will serve to simulate the operation of a large atomic power station by showing directly, and so without the need for elaborate calculation, how the essential factors involved change with time and interact with one another. With this machine it is hoped to be able to predict the performance of such a station under very varied conditions and to study the effects of alterations in design.

RECRUITMENT AND INTERNATIONAL COLLABORATION

The report concludes with a section on conditions of service, providing information about pay, pensions, housing and training; and a section dealing with the Authority's co-operation with similar bodies overseas. Assistance is being given to Commonwealth countries—the Authority has for example undertaken to help Australia in the construction of a reactor similar to DIDO—and to certain European nations. Considerable exchange of unclassified information is also taking place.

The United Kingdom was a joint sponsor of the United Nations resolution to establish an International Atomic Energy Agency and Her Majesty's Government have announced that they will contribute 20 kilograms of fissile material to the Agency when it is formed. Britain also played a prominent part in the International Conference on the Peaceful Uses of Atomic Energy held at Geneva last August. (Many of the papers presented at Geneva have been summarised in ENGINEERING, and descriptions of the exhibits shown there, including those of the U.K.A.E.A., have also been published.)

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POWER REACTOR PROJECTS THROUGHOUT THE WORLD

Reprints of ENGINEERING Article

The demand for copies of the article "Power Reactor Projects throughout the World" (ENGINEERING, October 7), has been so large that reprints are now being prepared. The article was written by Mr. G. W. K. Ford, of the Atomic Energy Establishment, Harwell, and is believed to be the most comprehensive analytical and comparative treatment so far published.

Copies will shortly be available at 2*s.* 6*d.* each post free from The Publisher, ENGINEERING, 35 & 36 Bedford-street, Strand, London, W.C.2. On orders of 12 or more the rate will be 1*s.* 6*d.*

PERSONAL

LT.-GENERAL SIR RONALD M. WEEKS, K.C.B., C.B.E., D.S.O., M.C., T.D., has decided to vacate his office as chairman of Vickers Ltd., Vickers House, Broadway, London, S.W.1., on May 31, 1956, by which date he will have passed the normal age of retirement from executive office under the company. THE VISCOUNT KNOLLYS, G.C.M.G., M.B.E., D.F.C., at present deputy chairman of the company, will succeed Sir Ronald Weeks as chairman.

The Council of the INSTITUTION OF PRODUCTION ENGINEERS, 10 Chesterfield-street, London, W.1, have set up a special committee to investigate the full implications of "automation." The chairman will be MR. A. F. KELLEY, B.Sc., A.M.I.Mech.E., M.I.Prod.E., A.M.I.C.E., of Rolls-Royce Ltd. Other members are SIR LEONARD LORD, K.B.E., President of the Institution; MR. G. R. PRYOR, chairman of Council; MR. H. G. GREGORY, vice-chairman of Council; MR. E. W. HANCOCK, M.B.E., of Humber Ltd.; SIR WALTER PUCKEY, immediate past-president of the Institution; MR. B. H. DYSON, of Hoover Ltd.; the EARL OF HALSBURY, of the National Research Development Corporation; MR. M. SEAMAN, of British Oxygen Engineering Ltd.; MR. R. TELFORD, of Marconi's Wireless Telegraph Co. Ltd.; and MR. F. G. WOOLLARD, M.B.E.

COMMANDER COLIN BUIST, M.V.O., R.N.(ret.), has been appointed deputy-chairman of Horseley Bridge & Thomas Piggott Ltd., Horseley Works, Tipton, Staffordshire.

MR. C. CONWAY, of James Morton Ltd., Sunderland, President of the British Nautical Instrument Trade Association, 105 West George-street, Glasgow C.2, and MR. H. E. REYNOLDS, of Dobbie, McInnes Ltd., Glasgow, vice-president of the Association, have been re-elected for a further year of office.

MR. H. V. POTTER, B.Sc., F.R.I.C., M.I.Chem.E., managing director of Bakelite Ltd., has retired after 40 years of service with the company and its predecessors. His successor if MR. G. W. HODDS.

CAPTAIN G. A. M. WILSON, R.N., is to be promoted to rear admiral with effect from December 12, and appointed deputy Engineer-in-Chief, in succession to REAR ADMIRAL R. W. PARKER, C.B.E.

MR. G. S. SAMWAYS, until recently joint managing director of the Metal Box Co. Ltd., has joined the board of Sanderson Brothers & Newbould Ltd., Newhall-road, Sheffield.

MR. R. J. COCHRAN has been appointed sales manager, plant department, Metropolitan-Vickers Electrical Co. Ltd., Trafford Park, Manchester, 17. MR. J. DYSON, B.Sc.(Eng.), A.M.I.E.E., has been made sales manager, transformer department.

MR. H. SWAIN, M.B.E., A.M.I.Mech.E., who has been secretary of the Institution of Heating and Ventilating Engineers since July, 1947, is leaving that position on November 30 to take up an executive appointment with Weatherfoil Heating Systems Ltd. He will be principally concerned with the sales development of the Dravo direct oil-fired space heater.

MR. PERCY ELLIOTT, who has been with the Butterley Co. Ltd., Ripley, Derby, since 1915, has been elected a director. For nearly 20 years he has held the position of secretary to the company.

MR. ROBERT ILLINGWORTH, O.B.E., M.I.E.E., M.I.Mech.E., who as generation engineer (construction), Central Electricity Authority, London Division, carried through the Brunswick Wharf generating station project, has retired after a lifetime associated with the electricity supply industry.

MR. N. E. W. SLOAN, of the motor-engineering staff of the British Thomson-Houston Co., Ltd., Rugby, has retired after more than 44 years of service with the company.

MR. H. E. SNOW, C.B.E., has been reappointed to the board of the British Petroleum Co. Ltd., as a managing director, on relinquishing his appointment as general manager of Iranian Oil Participants Ltd., on October 31.

MR. J. ADDISON has been appointed general manager of Iranian Oil Participants Ltd., Beaufort House, Gravel-lane, London, E.1, in succession to Mr. H. E. Snow. Mr. Addison has been secretary of the company since its formation last year. MR. K. L. LE PAGE has been appointed secretary.

MR. P. A. SINGLETON, managing director of Monsanto Chemicals Ltd., 8 Waterloo-place, London, S.W.1, since October, 1952, has resigned from the board in order to take up a new appointment with Monsanto Chemical Co., St. Louis, U.S.A. MR. D. R. MACKIE, commercial director, has been appointed acting managing director of Monsanto Chemicals Ltd.

Owing to his other responsibilities within the Associated British Engineering Ltd. Group of Companies, 9-10 Cavendish-square, London, W.1, MR. A. D. MACKAY has resigned the appointment of managing director of the Bergius Co. Ltd., and has been appointed deputy-chairman. MR. W. A. GREENHILL, who was assistant to Mr. Mackay, has joined the board and has been appointed managing director. MR. D. W. WILLOCKS continues as chairman of the company.

MR. B. A. WOODLEY has been appointed technical salesman of the special products (compositions) division of the Dunlop Rubber Co. Ltd. He will cover the Midlands.

MR. JOHN BOYLE, D.S.C., B.Sc., A.M.I.C.E., whose ancestor is known to all students of physics through Boyle's Law, has been appointed joint chief engineer to Ind Coope & Allsopp Ltd., Burton-on-Trent. He succeeds MR. J. H. WARDLE, who is retiring on medical advice but who will retain the appointment of consultant engineer to the company.

MR. JOHN SHIRREFF has been appointed vice-president of Johnson Matthey & Mallory Ltd., the Canadian associate company of Johnson, Matthey & Co., Ltd.

Birlec Ltd., Tyburn-road, Erdington, Birmingham, 24, a member of the A.E.I. group of companies, announce that MR. T. G. TANNER, technical director of the company, has been appointed deputy managing director, with effect from October 31.

MR. J. GLYN JONES has joined the technical sales staff of the Sheepbridge Group, Chesterfield, and will represent Sheepbridge Alloy Castings Ltd., and Sintered Products Ltd., in the north-western area. He will operate from 48 Rydal-avenue, Sale, Cheshire. MR. V. S. JACKSON of Hardinge Machine Tools Ltd. has now taken over the southern area as technical sales representative. MR. J. H. DAWSON has been appointed technical sales engineer, Twiflex Couplings Ltd., and will cover Southern England.

The Kellogg International Corporation, Kellogg House, 7-8 Chandos-street, Cavendish-square, London, W.1, inform us that MR. W. D. TATTERSALL has been appointed purchasing manager, as from November 1. MR. J. M. SEXTON, who has held this post, has been made purchasing manager to the newly-formed subsidiary company of the M. W. Kellogg Co., SOCIÉTÉ KELLOGG, with offices in Paris.

MR. J. MCFARLANE has been appointed sales manager for Scotland of the K.G.S. Bearing Co. Ltd., Macrome-road, Green-lane, Tettenhall, Wolverhampton.

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COMMERCIAL

As from November 14, the export department of MCKECHNIE BROTHERS LTD., is to operate from their London address, 14 Berkeley-street, London, W.1. (Telephone: HYDe Park 9841-7.)

WICKMAN LTD., Banner-lane, Tile Hill, Coventry, have established a new area office at 36 Market-street, Nottingham (Telephone: 43850). It is under the control of MR. E. J. SWINN. MR. GEORGE ARCHIBALD has been appointed acting area manager, Glasgow, in succession to MR. J. MACGREGOR.

FERRANTI LTD., Hollinwood, Lancashire, have opened a new research and development establishment of their aircraft-equipment department at "Westwick," Bagshot-road, Bracknell, Berkshire. The chief engineer is MR. W. A. MALLINSON and the chief research engineer, MR. J. W. BARNES, late of the Royal Aircraft Establishment, Farnborough.

GRIFFIN AND GEORGE LTD. announce that, as from November 7, all London and Southern Counties orders, inquiries and correspondence will be dealt with at their recently-extended offices and warehouse in Ealing-road, Alperton, Wembley, Middlesex. (Telephone: PERivale 3344). As from that date the GRIFFIN AND TATLOCK division at Kemble-street, Kingsway, London, W.C.2, has been closed.

WEST INSTRUMENT CORPORATION, Chicago, U.S.A., have formed a subsidiary company in this country, WEST INSTRUMENT LTD. The latter have now commenced operations at 1 Newman-street, London, W.1. (Telephone: MUSeum 3588) while their new factory at Hersham, Surrey, is being completed. MR. J. A. HARTNETT has been appointed managing director of the new company.

Plant for the production of some 130,000 tons a year of aviation spirit is to be installed at the Kent oil refinery of the BRITISH PETROLEUM CO. LTD., Isle of Grain. The cost is estimated at £6,500,000, and the plant is expected to be in operation in 1958.

CONTRACTS

Rails. The Pacific Great Eastern Railway of British Columbia, a Government-owned line but under independent management, has placed an order for 24,000 tons of rails and 4,000 tons of angle bars and tie plates to an approximate value of £1,160,000, with the UNITED STEEL COMPANIES LTD.

Colliery Winding Equipment. An order valued at well over £250,000 has been obtained by the BRITISH THOMSON-HOUSTON CO., LTD., Rugby, from the National Coal Board (North East Division, No. 2 Area) for two automatically-controlled tower-mounted electrically-driven, four-rope friction winding equipments for Brodsworth Colliery, Yorkshire. Each machine will be of the Ward-Leonard type, twin-motor driven, having a total driving horse-power of 2,700. Each equipment will consist of two direct-current motors, rated at 1,350 h.p., running at 600 r.p.m. The drum for each winder will be 12 ft. in diameter and arranged to accommodate four $1\frac{1}{4}$ in. diameter winding ropes in parallel. In the upcast shaft winding will be accomplished by a skip and counterweight arrangement, the net load of coal per skip being 20 tons, the winder having an output of 360 tons per hour. The downcast shaft will accommodate a cage and counterweight, the former having two decks and on each deck there will be two 3 ton mine cars, giving an output of 250 tons per hour. Men and material will also be raised and lowered in this shaft. The B.T.H. company will be the main contractors for the installation including the electrical portions and the main reduction gears. The sub-contract for the mechanical portions has been placed by B.T.H. with MARKHAM & CO. LTD., Chesterfield. It is expected that both equipments will be installed during 1958.

Ore-Handling Plant. An order, valued at over £600,000, has been placed by Colvilles Ltd. with the FRASER & CHALMERS ENGINEERING WORKS of the GENERAL ELECTRIC CO. LTD. It is for an ore-handling, storage and loading plant to be installed at the General Terminus Quay in Glasgow on the River Clyde. The plant comprises a double line of conveyors from the quayside and storage bunkers at the adjacent rail sidings. Each conveyor line has a capacity of 1,000 tons an hour. The quayside conveyors, each over 1,000 ft. in length, discharge to belt feeders from which further belts cross the roadway and convey for another 750 ft. to the bunkers. The storage bunkers have a total capacity of 14,000 tons.

Radar for Warships. A contract worth more than £250,000 has been awarded to MARCONI'S WIRELESS TELEGRAPH CO. LTD., Chelmsford, Essex, for the complete radar and communications equipment for two destroyers now under construction by VICKERS-ARMSTRONGS LTD. The warships are for the Chilean Government.

Helicopters. The first two of a batch of eight Whirlwind helicopters ordered from WESTLAND AIRCRAFT LTD., Yeovil, Somerset, for the French Government have been flown to a maintenance unit of the Royal Air Force for the installation of special equipment prior to being handed over to the French authorities. Delivery of the remaining six will be completed within the next few weeks. It has been announced in Paris that the machines will be used by the French Air Force in North Africa.

Ammonia Synthesis Plant. Imperial Chemical Industries Ltd., Billingham Division, have appointed the POWER-GAS CORPORATION LTD., Stockton-on-Tees, to act as the main contractors in connection with a substantial extension of their ammonia synthesis gas plant. The plant will be built under the overall technical direction of I.C.I. Ltd. Oil will be gasified with oxygen under pressure, and the equipment to be provided will also include oxygen plant, carbon monoxide conversion plant, gas-purification plant and compressors.

Automatic Telephone Equipment. The telephone organisation in Thailand have concluded negotiations with the telephone works, Coventry, of the GENERAL ELECTRIC CO., LTD., for the supply and installation of automatic telephone equipment in the capital city of Bangkok to a value of £300,000.

Electric Cable. In our paragraph,on page 592 of our issue of October 28, on the contract awarded to ENFIELD CABLES LTD., Victoria House, Southampton-row, London, W.C.1, by the Hydro-Electric Power Commission of Ontario, Canada, we regret that an error was made in quoting the conductor size. This was given as 300 cm., and it should have read 300 mcm. The expression "mcm" is an abbreviation for 1,000 circular mils., the conductor size being equivalent to 0·236 sq. in.

Obituary

MR. E. W. LAWRENCE, M.B.E.

News has reached us recently of the death, on September 20, at his home in Bath, of Mr. Edgar William Lawrence, who was works manager to Stothert and Pitt, Limited, Bath, for 44 years. Mr. Lawrence, who was 92 years of age, having been born in Malvern in 1862, had spent 63 years in the engineering industry. He served his apprenticeship with Messrs. Gratys, who owned a general engineering works in his native town, and upon concluding his pupilage entered the firm of John Hands and Sons, Limited, Birmingham. Shortly afterwards, however, he joined the staff of Bellis and Morcom Limited, then engaged in the manufacture of high-speed steam engines.

Mr. Lawrence was appointed assistant works manager to John Fowler and Company (Leeds), Limited, Leeds, in 1895, but about three years afterwards left to take up the position of assistant works manager to Stothert and Pitt, Limited, Bath. On February 1, 1899, he was made works manager and continued to occupy that position until his retirement, at the age of 81, in 1943. During his long career with the firm Mr. Lawrence was responsible for the construction of many harbour cranes and other heavy engineering port equipment.

For his services to his country in war-time he was awarded the M.B.E. in 1943.

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We also regret to record the deaths of:

MR. ERIC INGRAM MAVOR, of Capelrig, Newton Mearns, Glasgow, on November 6, at the age of 61. Mr. Mavor was the youngest son of the late Mr. Henry Mavor, the founder of Mavor and Coulson Ltd., Bridgeton, Glasgow, S.E. He was educated at Glasgow Academy and was subsequently apprenticed to an accountant. In the war of 1914-18 he served in the 6th Battalion Highland Light Infantry until severely wounded in Gallipoli. Joining Mavor and Coulson Ltd. in 1918, he was appointed secretary in 1929, a director in 1932 and joint managing director in 1940. He was also, from its inception in 1931, a director of M. & C. Switchgear Ltd., Kirkintilloch, a subsidiary company of Mavor and Coulson Ltd.

MR. EDWARD HIRST, which occurred on Monday, October 24. He joined the staff of the General Electric Co., Ltd., in 1904, and, after holding various appointments, became managing director of the General Electric Co. (of Belgium) Ltd., and in 1913, was appointed chairman and managing director of the British General Electric Co. Pty. Ltd., of Australia. He became vice-chairman and joint managing director in 1940; he resigned 11 years later, but was still on the board at the time of his death.

MR. ERNEST GERALD KING, at Chichester, on October 23. Mr. King, who was 78 years of age, was chairman of the Louis Cassier Company, Limited.

MR. ERNEST WILFRED SWALES, on October 20, at the age of 58. Mr. Swales was deputy managing director of Automotive Products Co. Ltd., Borg & Beck Co. Ltd., and the Lockheed Hydraulic Brake Co. Ltd., Leamington Spa.

MR. EDWARD BARTON WALKER, M.I.Mech.E., on October 7, in his 72nd year. Mr. Walker retired from the position of technical director of Walker Brothers (Wigan) Ltd., Wigan, on June 30, 1953. He joined the firm in 1903 as an apprentice and had completed 50 years of unbroken service. He was elected a director in 1920 and technical director in 1943. Mr. Walker was closely connected with the design and supply of large ventilating plant for mines and tunnels and was also responsible for the firm's Diesel railcars.

MR. EDGAR ARNOLD WRIGHTSON, on October 23, at Morpeth, Northumberland, at the age of 76. A retired shipbuilder, Mr. Wrightson was for many years shipyard manager to Sir John Priestman & Co., Southwick, Sunderland.

MR. GEORGE FREDERICK TWEEDY, O.B.E., a former manager of the Neptune Engine Works of Swan, Hunter, and Wigham Richardson Ltd. and a director of the firm, on November 2.

MR. HARRY JASPER COX, at Santa Barbara, California, U.S.A., on October 6. He was formerly a Principal Surveyor for the Far East to Lloyd's Register of Shipping. He retired in 1940 and was invited to join the Admiralty's technical mission in Canada. He remained with the mission until 1945.

Letters to the Editor

THE PRACTICE OF MANAGEMENT

A Valuable Book

SIR, I am sorry that your reviewer (October 28, page 593) did not like Mr. Peter F. Drucker's book *The Practice of Management*. I think it is one of the most valuable books on management that has appeared for some years. Moreover, it is written in such a refreshing and exciting style that I could hardly bear to put it down after I had begun to read it.

The reviewer ignored the many stimulating ideas on management practice, so ably discussed by the author, such as the manager's periodical letter to his chief—that craft organisation needs to be replaced by team organisation in modern production—that the time span of decisions depends upon the type of production—that management by drives is an admission of incompetence—that diversified mass production can now be achieved from standard parts—that the specific tool of the manager (in fact his only tool) is the written or spoken word and the language of numbers. "Of all the skills he needs," writes Drucker, "to-day's manager possesses least those of reading, writing, speaking and figuring." Does this help us to guess why so many engineers are not given the chance to make the grade as managers?

The discussion on decision making and its various phases is well worth the reading by most of the young engineers of my acquaintance. I like best his discourse on character—his description of the cold, severe, demanding man of integrity who commands more respect and teaches and develops more men than anyone else. It is time that this was said. I again quote:

"It may be argued that every occupation—the doctor, the lawyer, the grocer—requires integrity. But there is a difference. The manager lives with the people he manages, he decides what their work is to be, he directs it, he trains them for it, he appraises it, and often he decides their future. The relationship of merchant and customer, professional man and client requires honourable dealings. Being a manager, though, is more like being a parent, or a teacher. And in these relationships honourable dealings are not enough; personal integrity is of the essence."

No, Sir! I cannot agree with your review though I would grant that the book has some minor faults. For my part, I shall encourage all the production engineers and managers I know to read the book in the hope that they will absorb from it the stimulation and inspiration that I suspect they need.

Yours faithfully,

AUBREY BURSTALL,
Professor of Mechanical Engineering.

King's College,
University of Durham.
November 1, 1955.

* * *

RAILWAY TRACK FORMATIONS

Estimates of Cess Heave

SIR, With reference to the paper "Soil Mechanics in Railway Engineering," by Mr. A. H. Toms, appearing in ENGINEERING for September 16, in the section relating to track formation problems, my own experience has been that :—

(1) The two types of failure referred to, namely, pumping of clay slurry and cess heave, are distinct and can occur independently, calling for different remedial measures.

(2) The criterion for cess heave is not so much that the stress calculated to exist at some point exceeds the measured shear strength, but that there is a plane or zone of failure of such a nature that the cumulative disturbing forces along it exceed the restoring forces. Use of the former theory can result in recommendations for excessive excavation.

It would be appreciated if Mr. Toms could enlarge on this section of his article.

Yours faithfully,

J. S. HAINS.

65 Peplins Way,
Brookmans Park,
Hertfordshire.
October 28, 1955.

SIR, With reference to Mr. Hains' letter to you, I agree that there can be two independent types of track instability, viz. the pumping of clay slurry up through the ballast and the development of heaves alongside or between the tracks. These two conditions sometimes occur simultaneously.

Many cases are found where the ponding of water in the track in winter due to fouling of the ballast by dirt from various sources, not necessarily the soil under the track, results in very marked muddy pumping conditions. Often this condition is found where the original track was laid with a totally insufficient road bed.

Fig. 7 of my paper to which Mr. Hains refers shows typical cess heave conditions and, if reference is made to Fig. 29, page 235, Volume 4 of the Proceedings of the Second International Conference on Soil Mechanics, 1948, the accompanying text indicates that the strengths of the soil samples taken from below the track explain very readily the progressive circular heave movement. The mean measured shear strength of the clay in the failure zones was 360 lb. per square foot, which corresponds with border line equilibrium under a chair load of 10 tons spread 2 ft. 6 in. longitudinally. Loads well in excess of this have been shown to occur on a well packed sleeper.

Until more research has been done with pressure measuring cells on the actual stresses imposed on track formations, reliance will have to be placed on the technique developed on theoretical grounds on the basis of chair reactions recorded during research on concrete sleepers. Support for this policy is provided by the number of sites where blanketings carried out in accordance with this procedure have been opened up and found to be performing satisfactorily, whereas earlier blanketings, in which the excavation is considerably shallower, have failed.

The point which Mr. Hains makes about the criterion for cess heave is obviously correct, but what is not yet clear is whether it is safe to design on the basis of local overstress in restricted zones below the point of application of the load.

Further research on this matter is going ahead but far too little has yet been accomplished to justify pronouncement or any change in procedure.

Yours faithfully,

A. H. TOMS.

Office of the Chief Civil Engineer,
Southern Region, British Railways,
London, S.E.1.
November 4, 1955.

* * *

THE LOST CHORD

Tape recordings sent by air mail are an extremely useful and practical way of reporting back from far distant places. Many business firms use this method of communication to transmit and receive messages from their overseas representatives, but recently a tape with a message recorded on it was found to have no message when it reached its destination.

It appears that the magnetic field set up by the generators of the aircraft can completely erase a recording, although the numerous unaffected tapes sent and received show it is a very unusual occurrence. To guard against its possibility, the General Post Office say that it is understood that wrapping each recording tape carefully in tin foil prevents erasure.

EXTENSIONS AT SAMUEL FOX STOCKSBRIDGE WORKS

Increase in Alloy Steels

A year ago a 60 ton electric-arc basic steel-melting tilting furnace was installed in the works of Samuel Fox and Company, Limited, at Stocksbridge, near Sheffield, and the plant was described in our columns on page 830 of our issue of December 24, 1954. The firm, which is associated with the United Steel Companies Limited, 17 Westbourne-road, Sheffield, 10, now state that the furnace is tapping 70 tons and has proved to be an outstanding success.

A new furnace of similar capacity, forms the central feature of a £2,845,000 development scheme on which work is just beginning. This new extension will result in a substantial addition to the tonnage of special and alloy steels available each year for the motor-vehicle, aircraft, steam-generation plant, chemical-installation and other consuming industries. The additional annual production necessitates the reconstruction of the existing billet mill, in order to balance steel-making and rolling.

The second furnace is scheduled to be in operation by the end of 1957; it will be housed in the same melting shop as the existing furnace. The shell diameter of the new furnace, however, will be 20 ft., as compared with the 19 ft. of the first furnace, and it will be capable of producing between 1,400 and 1,600 tons of special steels each week. A 20,000 kVA transformer is to be installed for the furnace.

The present billet rolling mill at Stocksbridge is a 50 year old three-stand two-high steam-driven unit which, although still capable of many years' satisfactory working, is not designed to cope with the extra quantity of steel manufactured in the new furnace.

It has been decided to install two 32 in. two-high reversing mills independently driven by electric motors and equipped with mechanical manipulators, run-out racks, skids, a cutting-up line and transfer gear. One of the three present two-high stands is to be retained, together with its steam-engine drive. The new mills will be used on square-billet finishing and on the rolling of rounds and smaller slab sections, while the existing stand will roll mainly intermediate passes.

The rolling-mill reconstruction scheme will enable a varied rolling programme of some 8,000 ingot tons a week to be fulfilled. A new building, 770 ft. in length, by 105 ft. in width, is being constructed to house the rolling mills. Additional re-heating furnaces are also called for, as well as extensions to existing buildings to provide space for handling and processing the increased output of the mills.

* * *

THE JOINT IRON COUNCIL

Annual Banquet

During the first quarter of 1955, the production of iron castings exceeded one million tons for the first time in any quarter. This level of activity, after allowing for holidays, has continued unchecked in spite of difficulties presented by the railway and dock strikes. The output for the calendar year, 1955, is expected to be an all-time record, probably about 3·9 million tons.

The question of output was again referred to by Mr. N. P. Newman, J.P., President of the Joint Iron Council, at the annual banquet of the Council, held at the Dorchester, London, on November 1. In replying to the toast to "The Iron Industry," proposed by Mr. Peter Thorneycroft, President of the Board of Trade, he stated that, last year, measures had been taken to enable the industry to produce 4 million tons of iron castings per annum by 1960. In view of the increases recorded recently, however, this output figure had been revised to 4¼ million tons. In conjunction with the Iron and Steel Board and the Council of Iron Producers the problem of the production of low-phosphorus pig iron was being tackled and consistant support afforded for many scientific investigations undertaken by the British Cast Iron Research Association and similar bodies.

* * *

INSTITUTE OF WELDING

Petition for Royal Charter

Proposing the toast of the Institute of Welding at the annual dinner on November 2, Mr. F. J. Errol, M.P., Parliamentary Secretary to the Ministry of Supply, said that in addition to placing orders for weapons and equipment for the three Armed Services with leading firms, the Ministry maintained 21 Royal Ordnance Factories employing just over 50,000 persons. Some of the factories specialised in engineering production, others were concerned with the manufacture of explosives. Yet others were employed on the manufacture and filling of ammunition. These factories, which were necessarily of a specialised character, were well organised and efficient and a credit to all concerned. The Ministry was also responsible for the principal defence research organisations in this country. Much of the research carried out was necessarily of a very secret nature but whenever possible the results were published. Thus, in a forthcoming issue of ENGINEERING there would be an article by two of the Ministry staff, on "A Stud-Welding Technique for Thermocouple Wires."

In the course of his reply to the toast, the President, Mr. R. E. G. Weddell, said that the Council of the Institute had submitted to H.M. The Queen a petition for a Royal Charter in June, 1955, and it was known that the application was now receiving the active attention of the Privy Council.

In reply to the toast of the guests, proposed by Sir Charles Lillicrap, K.C.B., M.B.E., D.Sc., vice-President of the Institute, Major-General A. H. Gatehouse, D.S.O., M.C., referred to the great benefits of welding as applied to tanks and other fighting vehicles. He said that when a riveted tank was hit by a shell, the crew inside the vehicle usually sustained heavy casualties from the flying rivets loosened as a result of the shearing of the heads by the impact.

* * *

DISTRIBUTION OF ENGINEERS' TOOLS

Germany's Problems

The annual general meeting of the Association of Engineering Distributors was held on November 1 at the Park Lane Hotel, London, W.1. The retiring president, Mr. J. P. Lister, presented the balance sheet and reported that the association had been successful in dissuading some firms from adopting user discounts, and were negotiating with others. The meeting elected Mr. T. W. McConnell as the new president.

Following the meeting, Dr. Greifelt, director of the Association of German Machine Tool and Wholesale Tool Trades of Frankfort-am-Main, gave an address on the distribution position in Germany. He said that there were several organisations which worked together in harmony. The position had been very difficult in the immediate post-war years, and one of the worst problems was the internal competition and consequent price cutting. He considered a margin of 12 to 14 per cent. was required in the machine tool trade, and 18 to 20 per cent. for small tools. Under the present laws, price fixing by agreement was completely forbidden and the only way to tackle the problem was by the manufacturer setting a selling price and binding the retailer to adhere to it. He believed, however, that the best thing for trade and industry as a whole was freedom from restriction both internally and internationally.

The annual luncheon followed, at which the chair was taken by Mr. McConnell.

AID TO SCIENCE EDUCATION

Industry Forms Trust

Concerned at the growing shortage of scientists, mathematicians and engineers in Britain, 17 major companies (which are listed below) have co-operated in the establishment of an industrial trust to assist in the teaching of pure and applied science and mathematics in certain types of secondary school. The Trust is to be known as the Industrial Fund for the Advancement of Scientific Education in Schools and the monies subscribed are to be applied particularly to giving assistance to the independent and direct-grant schools that do not have the advantage of calls on public funds as is enjoyed by the maintained schools.

The assistance will be given solely by the provision of capital grants toward the building, expansion, modernising and equipping of science buildings in the schools that are selected in the United Kingdom, the Channel Islands and the Isle of Man. The independent schools—which include the recognised public schools—are not maintained by a local authority and do not receive any grant from the Ministry of Education. Direct-grant schools do receive help from the Ministry of Education and, in return, offer reduction in fees according to the incomes of parents; such schools are administered by independent governing bodies and include many of the old-established grammar schools of the country.

Over £1,500,000 has already been guaranteed to the fund, but, continues the announcement of its formation, "it is believed that many other companies that depend on adequate supplies of pure and applied scientists and technologists will wish to add their support, in their own as well as in the national interest. Indeed, only a shortage of time has prevented their being approached already."

The names of the 17 founder companies are:

Associated Electrical Industries, Limited; British Insulated Callender's Cables Company, Limited; British Petroleum Company, Limited; British Portland Cement Manufacturers, Limited, Group; Courtaulds, Limited; the Distillers Company, Limited; English Electric Company, Limited; Esso Petroleum Company, Limited; General Electric Company, Limited; Arthur Guinness, Son and Company, Limited; Imperial Chemical Industries, Limited; Imperial Tobacco (Great Britain and Ireland) Company, Limited; Rolls-Royce Limited; Shell Petroleum Company, Limited; Tube Investments, Limited; Vickers, Limited; and the Wellcome Foundation, Limited.

An executive committee has been formed, and it will be the responsibility of the committee to adjudge and assess all the applications. Its decisions will take into account both the volume and quality of the existing science teaching in any school, as well as the nature of the proposals put forward to extend and improve it and the steps which the school itself has taken to help itself. The members of the committee are:

SIR WILFRID ANSON, deputy chairman, Imperial Tobacco Company; MR. R. A. BANKS, personnel director, Imperial Chemical Industries; SIR HUGH BEAVER, managing director, Arthur Guinness, Son and Company (chairman); MR. E. H. O. ELKINGTON, director, Anglo-Iranian Oil Company; DR. WILLIS JACKSON, Director of Research and Education, Metropolitan-Vickers Electrical Company; MR. W. E. JENKINS, managing director, Esso Petroleum Company; PROFESSOR GRAHAM F. MUCKLOW, Professor of Mechanical Engineering, Birmingham University; MR. J. A. ORIEL, President, Institution of Chemical Engineers; DR. F. ROFFEY; DR. C. P. SNOW, Civil Service Commissioner; PROFESSOR SIR ALEXANDER TODD, Professor of Organic Chemistry, Cambridge University; LT.-GEN. SIR RONALD WEEKS, whose pending resignation from the chairmanship of Vickers is reported on page 654; and PROFESSOR A. H. WILSON, director in charge of research and development, Courtaulds.

The secretary of the Committee is Mr. Peter Ashton, of Courtaulds, Limited, and the address of the Fund is 20 Savile-row, London, W.1.

(Editorial Comment in Weekly Survey.)

Book Reviews

TECHNIQUES OF NOISE REDUCTION

Noise-Reduction Manual. By P. H. GEIGER. Prepared under the auspices of the Office of Naval Research. *Engineering Research Institute, University of Michigan, U.S.A.* (No price given.)

Though this monograph was prepared under the auspices of the Undersea Warfare Branch of the Office of Naval Research comparatively little information concerning underwater noises is contained in it, probably because much of it is still on the restricted list. It is mainly concerned with practical methods for the detection, analysis and reduction of air-structure-borne noises, which considerably increases its general interest.

The steps to be taken in tackling a noise problem are outlined in an introductory chapter. They consist of a reduction of the noise at its source by the use of resilient mountings to cut down the conduction of vibration to the structure on which it is mounted, the elimination of resonances, and the absorption of sound in transit from the source to the ear by means of appropriately disposed sound-absorbing materials or by housing the source itself in a suitably lined enclosure. Noise is primarily a matter of concern in so far as it affects human beings. Its disturbing effect is a subjective one and depends upon the characteristics of the individual human ear which, although a very remarkable organ, does not provide a sensation of loudness that is strictly proportional to the stimulus applied to the ear drum in the form of a cyclic fluctuation of pressure. The latter can be measured objectively in terms of a sound pressure level in decibels. The means whereby this can be translated by an observer into its equivalent in loudness level is described and a table given for converting from this into loudness units which, as the experience of the author confirms, accord closely with aural estimates of noise reduction. Other units useful in investigations on noise are the band pressure level and the spectrum level and, after defining these, a striking example is given to demonstrate the possibility, in converting from band pressure measurements to spectrum level, of the serious misrepresentation likely to arise from averaging over too broad a frequency interval.

Chapter III deals with sound absorption and insulation. Sound absorption coefficients are defined and reasons for preferring their measurement by the reverberation chamber method are explained. The dependence of sound absorption upon the thickness, manner of mounting, location and surface treatment of the specimen are then discussed and illustrated graphically. Valuable hints are given concerning the selection of suitable absorbents and their correct placing, the design of acoustical baffles and the computation of the noise reduction consequent upon acoustic treatment. To prevent the transmission of airborne sound through the walls of an enclosure is a more difficult problem and generally calls for the use of quite different materials and structures than those employed for sound absorption. Double partitions, if properly designed and free from leakage paths, are shown to be very effective. Methods of reducing machine noises by suitable housings are also considered and even partial enclosures are shown to be capable of affording some relief from noise provided care is taken over connections supplying the machine through the walls. Sound transmission along ventilating ducts is a frequent source of trouble and its attenuation by means of bends, splitters and baffles is explained.

Vibration damping is dealt with next and illustrated by a detailed account of methods developed by the author to damp down vibrations set up in the sheet metal panels of automobile bodies. Damping is needed here to eliminate the effects of resonance between vibrations generated in the engine and the various parts of the body as well as to reduce body noises due to shock excitation when the car passes over a rough road. Techniques for ascertaining the natural frequencies of, and for delineating the vibration patterns set up in, automobile door panels are described, together with methods for applying mastic deadeners and checking their effectiveness. Preliminary details are included of a frequency-selective damper of simple construction that can be designed to afford maximum damping in the troublesome low-frequency range while still retaining a reasonable effectiveness at higher frequencies. The use of resilient mountings to prevent the transmission of vibration from a machine to its support is fully treated in Chapter V. Illustrations of representative commercial types of mountings are included and the special features of each indicated. Practical directions are provided for the proper location of mounts on machines and for suitable forms of connections to resiliently mounted machines.

The concluding chapter provides an admirable survey of measuring techniques, upon the results of which any rational proposals for noise abatement must be based. Reasons are adduced for preferring one type of instrument to another, for example, a dynamic rather than a crystal microphone. Without entering into the constructional details of individual instruments the precautions needed to get consistent readings from them, such as the provision of compensating windings to eliminate stray magnetic pick-up in microphones, frequent calibration of sound level meters, rotating reflectors for averaging out the effect of standing wave patterns, are carefully described. Noise reduction has usually to be accomplished in steps so small as not to be readily discernible by the ear. Experience, care and patience are all called for in tracing and treating causes contributing to noise. There are, as the author states, no routine manipulations in making noise analyses.

Within a small compass and with practically no mathematics this book contains a wealth of scientifically based practical advice and the recommendations contained in it will prove invaluable to engineers engaged in the detection, analysis and reduction of noise.

* * *

BOOKS RECEIVED

Some of the books noticed here are selected for extended review in ENGINEERING.

Crane Specification for Heavy Duty Electric Overhead Travelling Cranes for Use in Iron and Steel Works. *British Iron and Steel Research Association*, 11 *Park-lane, London, W.*1. (10*s.* to non-members.)

In this revised edition, an attempt has been made to reduce the cost and weight of a crane. Variable fatigue factors have been specified, and the fuller understanding of stresses in the structure gained by experiment has been incorporated in the specification.

An Introduction to Port Working. By A. H. J. BOWN. *National Dock Labour Board*, 9 *and* 10 *Upper Brook-street, London, W.*1. (2*s.* 6*d.*)

This book describes in simple language the working of a port. The main subjects are the movement of goods to, from, and at a port; the traffic and goods passing through, and the relation of ports with world trade routes; and organisation and financing, with accounts of dock labour and industrial relations. The book is designed as a handbook for use in training classes for dock workers.

Seafarers and their Ships. *H.M. Stationery Office, Kingsway, London, W.C.*2. (3*s.* 6*d.*)

This booklet describes the progress made in the safety of British merchant shipping and the well-being of merchant seamen during the last hundred years. The progress is closely related to the legislation which has been brought in from time to time to ensure safety and reasonable living conditions.

Fuel—Solid, Liquid and Gaseous. By J. S. S. BRAME and J. G. KING. Fifth edition, rewritten by J. G. KING. *Edward Arnold (Publishers), Limited*, 41 *Maddox-street, London, W.*1. (50*s.*)

The fifth edition, like previous editions, is limited strictly to the properties of fuels and their methods of application. Five chapters concern general aspects of fuels, including fuel analysis, determination of calorific value, and fuel efficiency. The main part of the book deals with coal and oil and their derivatives, and gaseous fuels. Items discussed in more detail in this edition are: pulverised fuel, conversion of coal to oil, catalytic cracking of oil, and instrumentation to increase fuel efficiency. The book is a comprehensive introduction to fuel technology for engineer or industrialist.

Builders' Materials. By BERNARD H. KNIGHT and RENA G. KNIGHT. Third edition. *Edward Arnold (Publishers), Limited*, 41 *Maddox-street, London, W.*1. (30*s.*)

In the preface the authors say that the book has been written for the architect, builder, quantity surveyor, civil and structural engineer and is intended not only for practitioners but also for students preparing for examinations of their respective professional institutions. Over and above the chapters on brickwork, concrete, timber and steel, there are sections dealing with non-ferrous metals, linings and sheetings, asphalts, decorative materials and comfort criteria. Appendices relate to by-laws, codes of practice and British Standards. In all respects this new edition has been revised to include the wealth of development in materials and processes that has been made since the war.

Geology in Engineering. By JOHN R. SCHULTZ and ARTHUR B. CLEAVES. *John Wiley and Sons, Incorporated*, 440 *Fourth-avenue, New York* 16, *N.Y., U.S.A.* (8.75 dols.); and *Chapman and Hall, Limited*, 37 *Essex-street, London, W.C.*2. (70*s.*)

This book has been written with the two-fold purpose of introducing engineers to geology and, what is possibly a greater need, geologists to engineering. Thus a considerable part of the book is devoted to explaining the applications of geology in modern civil engineering and of discussing the engineering practices involved. A short introduction is given to soil mechanics as applied to relatively small areas, but the book is primarily concerned with more extensive surveys as appropriate to a geological approach. The preface suggests that the book might be used as a basis for two-term courses of instruction (at American universities) but it will also be of value to the man who has left college and recently begun to practise engineering.

Analysis of Statically Indeterminate Structures. By JOHN I. PARCEL and ROBERT B. B. MOORMAN. *John Wiley and Sons, Incorporated*, 440 *Fourth-avenue, New York* 16, *N.Y., U.S.A.* (9.50 dols.); and *Chapman and Hall, Limited*, 37 *Essex-street, London, W.C.*2. (76*s.*)

This is the first of what is intended to be a two-volume treatise on the analysis of statically indeterminate structures. As such, the present book forms an introduction to the subject by discussing the basic theory of such structures and developing the methods appropriate to those problems commonly met in practice. The second volume will then be restricted to practical problems that occur infrequently or are of great complexity. The volume now published fully covers the subject as required by the undergraduate specialising in theory of structures and pursues analysis in a form suitable for post-graduate study at American universities. The numerous practical problems analysed make the book a suitable manual for design offices engaged in this field of work.

Concrete Manual. Sixth edition. United States Department of the Interior, Bureau of Reclamation. *The Superintendent of Documents, U.S. Government Printing Office, Washington* 25, *D.C., U.S.A.* (2.50 dols.)

The *Concrete Manual* is prepared in the Engineering Laboratories of the U.S. Bureau of Reclamation and as such is a handbook of modern concrete practice, covering the choice of materials, mix design, handling and placing, compaction, and surface treatment. New material in this sixth edition includes references to recent work on the strength of concrete, the use (and limitations) of air-entrained concretes, and the precautions to be taken when using calcium chloride additives where sulphate attack is expected. Recommendations are also given for the protection of new concrete during conditions of freezing.

Magnetic Materials in the Electrical Industry. By P. R. BARDELL. *Macdonald and Company (Publishers), Limited*, 16 *Maddox-street, London, W.*1. (32*s.* 6*d.*) (Reviewed on page 625, in the issue of November 4.)

DETERMINING THE CRITICAL LOAD FOR FRAMED STRUCTURES

TWO EXPERIMENTAL TECHNIQUES FOR ESTIMATING THE ONSET OF ZERO STIFFNESS

By D. B. Chandler, B.SC.(ENG.), PH.D.

There is a need for more methods that permit the rapid determination of the critical load of structures, i.e., the load at which a structure would offer no resistance to applied disturbances if its members remained elastic.[1] *Theoretical techniques have been examined by, among others, Lundquist,*[2] *Winter*[3] *and Hoff.*[4] *At the present time the chief experimental method is due to Southwell.*[5] *Two experimental techniques have been developed by the author and tests have been carried out on one-, two- and three-storey, single-bay portal frames. This article is concerned with the results of these tests.*

THE MODELS

It will be seen from Fig. 1 that the basic dimension of the models is 12 in. For simplicity all members are made of $\frac{1}{2}$ in. by $\frac{1}{16}$ in. bright rolled mild-steel strip. As the members framing into a joint are at right angles, connection is conveniently effected by soldering into a cylindrical cleat in which four radial slots have been milled. The insertion of a rod through the axial hole drilled in each cleat provides a simple method of panel point loading, as is shown in Fig. 2. The loading pattern selected consisted of equal loads P at the top panel points only. To mount the model on a baseplate, a shoe was soldered on to the foot of each column. Fig. 3 shows a model under test.

SOUTHWELL ANALYSIS

The standard method of analysis due to Southwell,[5] when applied to frames of the type being considered, is to load the structure gradually and observe the lateral deflection of the panel points. A hyperbolic relationship is assumed to exist between the load and these deflections. If Δ_0 is the deflection of the unloaded structure and Δ the corresponding deflection at a load P, then a graph of $\frac{\Delta - \Delta_0}{P}$ against $\Delta - \Delta_0$ will be a straight line. The inverse slope of this plot is the critical load P_c.

Unfortunately this method cannot always be relied upon, as the relationship between P and Δ, being dependent upon imperfections arising from manufacture, is sometimes non-hyperbolic. For example, in the case of a pin-ended strut it may be demonstrated that the relationship is of the form

$$\Delta = \frac{a_1}{1 - \frac{P}{P_{c_1}}} + \frac{a_2}{1 - \frac{P}{P_{c_2}}} + \ldots . \frac{a_n}{1 - \frac{P}{P_{c_x}}}.$$

Although a formal proof is lacking, such an equation is often applied to structures in general. Any such imperfections in the model may therefore be considered as composed of components in the separate buckling modes, each one of which is magnified independently. If the component of the primary buckling mode overshadows the others, a linear plot results, as a hyperbolic relationship of the form $\Delta = \frac{a_1}{1 - \frac{P}{P_{c_1}}} + d$ exists.

If, however, the component does not dominate the equation, a linear plot is not obtained and the critical load cannot be predicted with any degree of accuracy. Such curves have been reported, as, for example, the tests on the Margam plate girder.[6] The method suffers from a further drawback in that settlement or bedding of the structure during loading nullifies all observations. These factors prompted the present investigation.

METHOD OF STATIC STIFFNESS

The stiffness of a structure to any applied disturbance which excites some component of the buckling mode is zero at a critical load. A convenient way of estimating this load is to plot the stiffness against the load, the intercept of the curve on the load axis being the critical value of the load. Maintaining the load P constant, and applying a horizontal disturbing force Q at any panel point, the magnitude of the disturbance Q is gradually increased and the corresponding deflection δ of the panel point measured. If the disturbance is small, there is no appreciable change in the axial loads of the members and the relationship between Q and δ is linear. If, however, the disturbance becomes excessive, the relationship becomes non-linear due to the variation in the axial loads. The stiffness of the structure K to the particular disturbance chosen is given by the slope of the graph at zero disturbance.

Fig. 4 is typical of the stiffness curves obtained for a disturbance at the top panel points of the models. Fig. 5, which gives curves for disturbances at other panel points, has, for convenience, been made non-dimensional by plotting $\frac{K}{K_0}$ against $\frac{P}{P_c}$. This illustration demonstrates that the shape of the stiffness curve depends upon the magnitude of the component of the buckling mode present in the disturbance. The larger the component, the less will be the influence of the higher critical loads and the smaller the general curvature. Since the disturbance determines the shape of the curve, it is worth taking some trouble in selecting a suitable disturbance to test a structure, especially if the critical load is to be predicted by extrapolation from a limited number of stiffness-load observations. When examining structures in which plastic effects intervene before the load even approaches the critical, the importance of this cannot be over-emphasised.

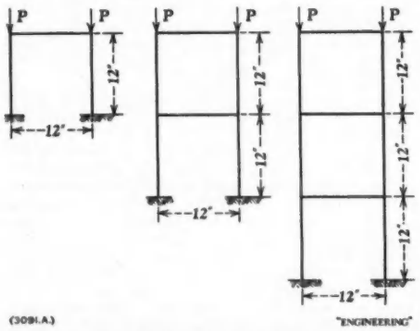

Fig. 1 Three simple models have been used to examine the proposed methods for determining the critical load that would cause a structure to exhibit zero stiffeness.

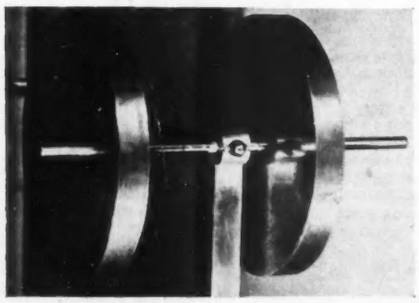

Fig. 2 Connections between members were made with drilled cylindrical cleats. Panel point loading was provided by weights on a rod through the cleat.

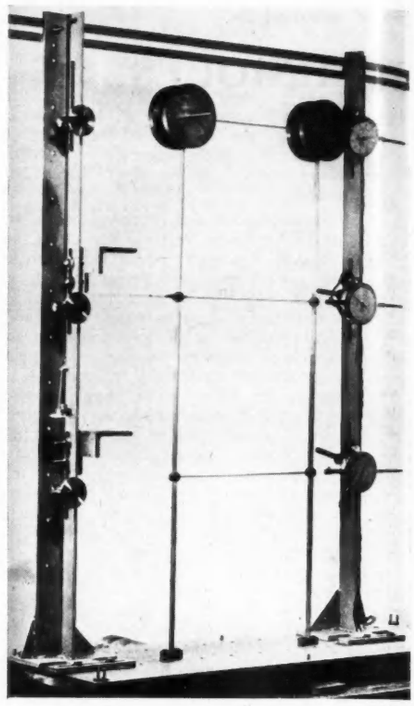

Fig. 3 The three-storey model under test, showing the methods adopted for applying "disturbances" at the panel points and for measuring deflections at the panels.

METHOD OF "VIBRATION" STIFFNESS

During the investigation it was observed that the natural frequency of oscillation of a model decreased with load. Since the momentum of the vibrating loads acts as a disturbance at the top panel point, it is easy to calculate the stiffness of the model if the motion of the loads is assumed to be simple harmonic. Because of torsional inertia this assumption is not strictly correct, but the error involved is negligible. The predicted stiffness K_v will, of course, slightly

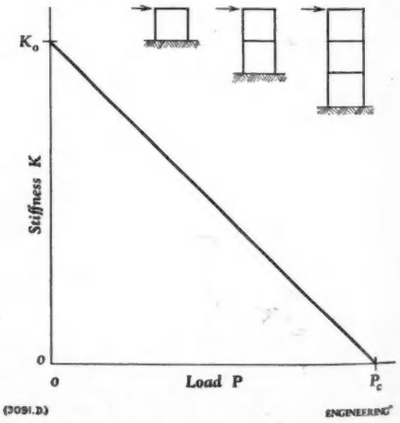

Fig. 4 The relationship between the frame stiffness and the load is almost linear for a disturbance applied at the loaded panel point, and the graph can be extrapolated to find the critical load, corresponding to a zero stiffness of the frame.

underestimate the true value K. If x is the distance of the loads from their equilibrium position, then the inertia force is $\frac{2P}{g}\ddot{x}$ and the resistance of the model to deformation is $K_v x$. The resulting equation of motion is

$$\frac{2P}{g}\ddot{x} + K_v x = 0$$

and its solution is $K_v = \frac{8\pi^2 P}{g t^2}$, where t is the period of oscillation of the model under the load P. A correction for the weight of the model is easily made. For this test the only data required are the variation in the period t with the load P. Using this information a stiffness curve may be plotted, and by extrapolation an estimate made of the critical load.

Fig. 6 is typical of the vibrational stiffness curves obtained. The slight scatter is attributed to the variable inertia of the loads. An allowance for inertia effects has been made in the case of the single-storey frame and the true stiffness K calculated. The corrected values were found to agree with those determined by the previous method, as is demonstrated in Fig. 7. As expected, both the K_v and K curves predict the same critical load.

SUMMARY OF RESULTS

The theoretical critical load of each model was also determined. This analysis was based on methods similar to those introduced by Merchant[7]; allowance was made for:

(i) the stiffening effect of the cleats on the members[8], and

(ii) the load in each member due to the self-weight of the frame.

A summary of the experimental and theoretical values is given below. The results of a standard Southwell analysis have also been included.

Model	Critical load (lb.)			
	Theoretical	Southwell	Static	Vibrational
Single storey ..	16·74	16·71	16·80	16·80
Two storey ..	11·56	11·70	11·58	11·66
Three storey ..	10·14	10·00	10·15	10·20

When judging the results of the Southwell analysis it must be remembered that the models were suited for this type of test, the manufacturing imperfections present constituting a component in the side sway buckling mode.

In conclusion, it must be emphasised that since the suggested techniques are based on the variation of the stiffness of the structure with load, they do not suffer from the experimental drawback referred to earlier. Settlement and bedding, although distorting the internal stresses in the members, have little effect on the geometrical shape of the structure and, in consequence, the stiffness at a given load.

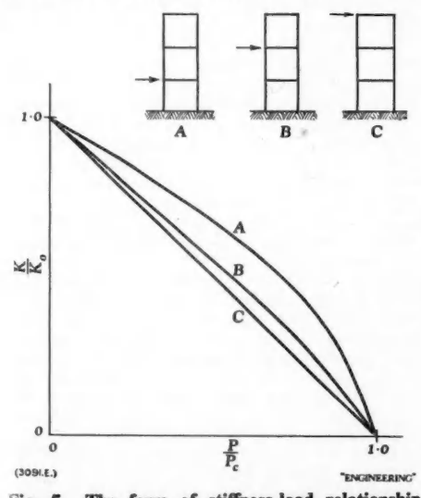

Fig. 5 The form of stiffness-load relationship depends upon the point of application of the disturbance; location of the disturbance in experimental determinations is important if the curve is to be accurately extrapolated to find the critical load.

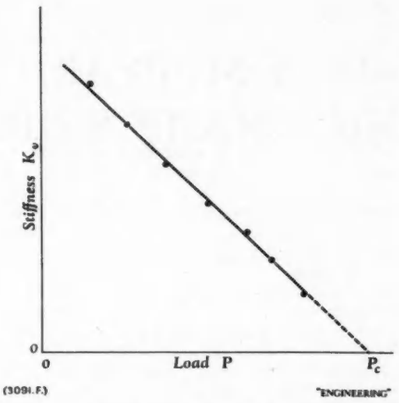

Fig. 6 The period of vibration of the structure varies with the magnitude of the applied load and is dependent upon the stiffness corresponding to the load. The critical load corresponds to the extrapolated zero " vibration " stiffness, K_v.

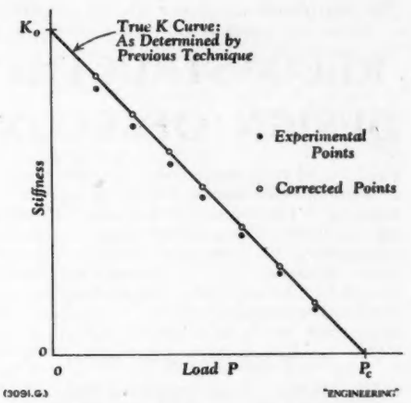

Fig. 7 Direct observation of the " vibration " stiffness ignores the inertia of the frame but correction factors can be applied and agreement between the two methods of determinations obtained.

ACKNOWLEDGMENT

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FERROUS MATERIALS FOR SPECIFIC PURPOSES

Crankshafts, Gears, Pistons and Marine Propellers

In the course of the 24th Andrew Laing Lecture which he delivered before the North-East Coast Institution of Engineers and Shipbuilders, Newcastle-upon-Tyne, on October 28, Dr. S. F. Dorey, C.B.E., F.R.S., Chief Engineer Surveyor, Lloyd's Register of Shipping, considered some of the more recent trends in the uses of iron and steel in marine engineering. The title of his lecture was " Ferrous Materials in Marine Engineering."

He stated that during recent years considerable progress had been made in the use of spheroidal-graphite irons for cast crankshafts. While the aim was to produce large components with a journal of up to at least 9 in. in diameter, the present production concerned small shafts of 6 in. diameter and below. A trend to the large crankshaft, however, was inevitable. One advantage advanced for the cast crankshaft related to the greater possibilities casting techniques offered with regard to obtaining shaft forms of maximum strength. The " ideal " shapes of webs, pins and journals, and compensation for oil holes were readily achieved by foundry practice.

Of late years an important feature in steam-turbine rotor manufacture had been the increased application of non-destructive testing methods by the principal forges and engine builders. For many years examinations of the rotor bores by boroscope, either dry or after spraying with " magnetic ink " following the magnetisation of the forging, had formed the principal inspection method. Ultrasonic methods were now employed to supplement this procedure.

Up till the 1939-45 war period, few departures had been made in the materials accepted for the reduction gearing of steam turbines. The well-tried steels comprised 3½ per cent. nickel types for forged pinions, either air or oil-hardened, and tempered to a minimum hardness of 185 Brinell number. The mating material of the hollow-forged gear-wheel rim was a medium-carbon steel normalised to a hardness range of 137-173 Brinell numbers. Departures from these materials had arisen for two main reasons: first, a need to conserve nickel and, secondly, the requirements in certain cases for steels of superior properties to withstand higher tooth loading and provide greater wear resistance. For the former a 3 per cent. Cr-Mo steel had been accepted for pinion forgings. The hardenability of this alloy was superior to that of the nickel steel and with this higher hardness a 0·40 per cent. carbon steel or a 1 per cent. nickel steel might be suitable for the gear wheel.

In the matter of piston materials, the latest departure of considerable interest concerned the use of cast spheroidal-graphite-iron crowns, particularly for main and exhaust pistons.

The incidence of caustic cracking in the mild-steel plate forming the riveted seams of cylindrical boilers was still a matter of concern. Suggested feed-water treatments appeared to be the only substantial proposals made.

Cast irons retained a predominance over other ferrous materials for the manufacture of propellers but the severe damage sustained by them in service due to cavitation erosion had long been a matter of concern. In this country a 14 per cent. chromium, 1 per cent. nickel steel had been adopted for propeller manufacture. The castings were generally normalised from about 980 deg. C., and tempered at 650 deg. to 750 deg. C. to relieve casting stresses; the resulting tensile strength was of the order of 40 tons per square inch. In service these high-chromium steels displayed a high resistance to corrosion and cavitation erosion. They were employed for many other land and marine hydraulic components, including pump impellers, water-turbine runners and Pelton wheels.

The Institution of Naval Architects Autumn Meeting (concluded from page 629)

RECONSTRUCTION OF A SHIPYARD: DESIGN OF ECONOMIC TRAMP SHIPS

The second paper presented in the morning of Wednesday, September 21, during the Autumn Meeting of the Institution of Naval Architects, and the fifth of the six comprising the complete programme, was contributed by two Yugoslav naval architects, Mr. M. Stanger and Mr. S. Ercegovic. It dealt with "The Recent Development of the Shipyard at Split." The chair was again taken by Mr. Norman M. Hunter.

THE SHIPYARD AT SPLIT

The shipyard which the paper described has passed through many phases and has been situated on more than one site. It has been on the present site since 1925, and six years later was bought by the Ateliers et Chantiers de la Loire. At one time Messrs. Yarrow and Company were also associated with it. Eventually it became the Adriatic Shipyard, Limited, and was used for building destroyers for the Yugoslav Navy. A floating dock of 3,500 tons lifting capacity was added to the equipment and a considerable amount of repair work was undertaken. During the second World War the yard was destroyed by bombing, and after the war the decision was taken to reconstruct it completely, with much improved facilities. As redesigned, it was made capable of working 30,000 tons of steel annually and suitable for building merchant ships as well as naval craft. The plan was to be able to handle also repair work up to the amount of 2,000 tons of steel in a year, and to employ both welding and riveting. The building berths were increased in number from two to five, one being 170 m. (518 ft.) in length and the others about 135 m. (412 ft.). These resources, it was considered, would suffice for the production of about 13 merchant ships annually, totalling about 40,000 tons deadweight. The designers of the yard had to take into consideration the fact that the machine tools available would be obtained mainly from German reparations. Each building berth would be served by two 25 ton cranes, so that, when welded construction was undertaken, sections of 50 tons could be lifted. The paper concluded with a comparison of the new with the old shipyard. In 1940, the area of the site was 17 acres, there were two berths covering together 3,300 sq. m., only six self propelled cranes, and employment for 1,250 persons. At the present time the site covers 100 acres, the five berths occupy a total area of 18,500 sq. m., there are 65 self-propelled cranes, and the total number of workers is 4,000.

DISCUSSION: LABOUR FORCE AND PRODUCTION

The discussion was opened by Mr. A. R. Mitchell, M.B.E., who remarked on the high pressure of work that was assumed in the planning of the yard; 690 tons a week, or 35,800 tons a year, was a huge figure for a small yard to prepare, and the rate of erection, given as an average of 675 tons a week, when working an eight-hours shift, was also a notable performance. From the diagram showing the occupation of the storage area when building a 10,000 tons tramp, it would seem that only 4½ months were occupied in erecting 2,600 tons of steel—and, to produce the output stated of 13 ships a year, work must proceed at that high rate on all five berths, making a total of 34,000 tons. Those figures, for a yard with a total labour force, for all trades, of 4,000 men, seemed a remarkable achievement. It was far in excess of twice the output of his own Clydeside yard, which had a labour force of 2,000. He doubted whether it would be possible, with the machine tools listed, to produce in the time the material for the prefabricated units referred to in the paper. The amount of material and machine tools in the yard was about half the amount in his own yard, with its 2,000 men, and the 15 ft. plate bending rolls seemed very small for a yard building vessels up to 518 ft. in length. Had the yard at Split actually produced 13 ships, each having nearly 2,600 tons of steel, in a particular year, or did the paper merely imply that it was so organised that, if it had orders for 13 ships, it could produce them in one year?

Mr. J. D. Calder remarked that, in the paper dealing with the Uljanik shipyard, the plan of the yard included a useful scale; in the present paper there was an equally good plan but it bore no scale, which made it difficult to appreciate the size of the yard. The members were to have the pleasure of visiting the shipyards at Rijeka and at Split. The great contrast between the two was striking, because whereas the yard at Rijeka was handicapped by lack of space, it seemed that Split was handicapped because they had almost too much.

Mr. F. N. Boylan said that one difficulty in building up a yard from small beginnings was that of organising the labour into the most modern and up-to-date methods of working. He thought that had been done in Yugoslavia. One of the bugbears in British shipyards was the subdivision of labour; to get a fitting placed in a ship it was often necessary to employ four or five trades. Did any similar subdivision exist in Yugoslavia? If, for instance, a job was given to the wrong trade, had the other trade any organised means of protest? Was a strike possible in Yugoslavia? If the subdivision of labour could be avoided, so that opportunity could be taken to reorganise the trades into really up-to-date methods of working, without opposition, they would have a considerable advantage in building up new yards.

Mr. Stanger, who had presented the paper, having intimated that he would reply in writing to the discussion, the meeting was adjourned until the afternoon.

The sixth and last paper in the programme, which was discussed in the afternoon of September 21, was "On Design of Economic Tramp Ships," and was presented by Dr. E. C. B. Corlett. The chair was taken for this concluding session by Mr. R. B. Shepheard, C.B.E., B.Sc.

ECONOMIC TRAMP SHIPS

Dr. Corlett introduced his paper with an interesting historical survey of tramp ship characteristics over the past century, and a comparison of the cost of transporting cargo for a voyage of 4,000 miles in corresponding ships of 1919, 1935 and 1955. He showed that a 1919 ship of 7,000 tons deadweight capacity, costing £70,000, would carry her cargo at a cost of 0·024*d.* per ton-mile. For 1935, he took a ship of 7,500 tons deadweight, costing £155,000 to build; her operation cost was 0·042*d*, per ton-mile. A vessel of similar dimensions, with a total deadweight capacity of 7,900 tons, would cost £560,000 in 1955, and her cost per ton-mile would be 0·084*d.* Thus it appeared that the operating cost per ton-mile had doubled in the 16 years from 1919 to 1935, and had redoubled in the next ten years. The current preference of owners, Dr. Corlett indicated, was for shelter-deck ships of about 10,500 tons deadweight, with a trial speed of 14½ to 15 knots.

The author then proceeded to analyse the principal features of a tramp ship in the light of current practice, and to suggest directions for further development. In the concluding section of the paper he put forward four designs for ships designed on the lines that he proposed, namely, a 450 ton coaster, a short sea tramp of 3,000 tons deadweight, a slow vessel of 11,000 tons deadweight, and a fast tramp of the same capacity. In all four designs the machinery was aft, the main propelling engine being an oil engine in each case. The first two of the four designs included three-ton traversing cranes for cargo-handling, these cranes being mounted on the slab hatch-covers. Another interesting suggestion was to fit trunking in the 'tweendecks, between the upper-deck and lower-deck hatches, and to use the compartments thus formed for the carriage of supplementary water ballast.

DISCUSSION: CARGO HANDLING AND PROPELLING MACHINERY

The discussion was opened by Professor Ing. S. Silovic, who remarked that there was not much advantage in increasing the sea speed of a ship unless the speed of turning-round in port could be increased also. This might be done in many instances, he suggested, by a better arrangement of standard cargo-handling equipment. For example, it was the normal practice to have two coupled derricks at work over one hatch, but each individual cargo winch had its own operator. It should not be difficult to connect the controls of both the winches of coupled derricks so that only one operator was needed to handle them, which would make the loading and unloading of a ship both faster and cheaper.

In the paper, the author showed the relationship between the relative cost per ton-mile and the ship's speed. In an analysis of the economic speed of a tramp of the same deadweight as Dr. Corlett's, Professor Silovic said that he had come to the conclusion that the optimum speed increased with the increase of the ratio of permanent costs to fuel costs and that to-day, in the case of a tramp of 10,000 tons deadweight, it would vary from 14·25 knots to 15·75 knots.

If a modern tramp ship were built with a closed shelter deck, but so constructed that as to be used as an open shelter-decker also, she could operate as a tramp or as a cargo liner. Bearing in mind, however, that it was usual to run the main propulsion motors at not more than 80 per cent. of their output; that, at that reduced power, they must give the required service speed; and that, due to fouling and average weather conditions, the resistance of the ship would increase from 20 to 25 per cent. above the resistance on the trial trip, he thought that the output the author gave for his Case No. 4 was really at the lower limit. The required output of the propelling machinery would be between 8,000 and 10,000 h.p., so that, although it was supercharged, the main engine was of quite respectable size, occupying a relatively large part of the ship's length. The most important advantage of the Diesel engine was its low specific fuel consumption, which meant higher net deadweight, greater hold capacity and cheaper operation; but an output of 8,000 to 10,000 h.p. could be obtained from a steam turbine installation, which was considerably cheaper to build, needed much less room and had considerably less weight. In that power range, the Diesel motor no longer had an advantage over the steam turbine. In conclusion, he asked the author's opinion on the reason why the United States did not develop the production of heavy slow-running Diesel motors for ship propulsion.

Mr. A. R. Mitchell, M.B.E., thought that the author's remarks on the relative influence, on the general overall economics of running a ship, of cargo handling and speed of turn round on the one hand, and economies in propulsion on the other, were most pertinent. Many of the inquiries received for small vessels, from countries such as Burma and India, called for a speed/length ratio that was much too high, resulting in high horse-power, high fuel consumption, and increased weight of machinery and fuel, with consequent loss of deadweight and increase in draught. The cargo handling arrangements also left much to be desired.

While he was in sympathy with the author's views regarding the so-called straight line forms, he was pleased to note the qualification that no simplified form was worth incorporating in an expensive ship unless it could be shown to be fully the equal of a conventional form as well as

being of lower inherent building and repair cost. There was a tendency on the part of many engaged on the production side of shipbuilding to want to apply straight-line construction to every type of vessel on the pretext of economy in construction, regardless of every other consideration. He did not, however, share the author's enthusiasm for the completely welded shell; there was relatively little loss in power between the vessel with welded butts and riveted seams and the all-welded shell. For various constructional reasons, some builders still favoured welded butts and riveted seams; and on both naval and merchant work at the present time, riveted seams above the waterline, to act as crack arresters, were frequently called for. He would be interested to know if the author had been concerned in the design of tramps capable of dealing with really heavy lifts—up to, say, 200 tons—for most of the vessels of that type were not British-owned.

SHAPE OF FOREBODY

Professor Dr. Ir. W. P. A. van Lammeren disagreed to some extent with the author's statement that it was customary on the Continent to adopt markedly V-shaped forebody sections in the range of block coefficients considered; the Netherlands Ship Model Basin preferred moderately U-shaped forms in the forebody. In most cases it was found from model experiments that there was little difference in the required effective horse-power for different shapes of forebody. Dr. van Lammeren then showed body plans of three models of the type of ship under discussion, having the same afterbody, but three different forebodies. All the models had the same curve of sectional areas and the same prismatic coefficients. For the lower speeds, the extremely V-shaped forebody gave slightly better results, whereas for higher speeds the V shape was definitely less favourable. That could be explained by the V shape having a relatively small wetted surface, so that the frictional resistance was comparatively low; whereas the wave-making properties of such a form were less favourable, so that there was a greater wave-making resistance at higher speeds.

On the other hand, the forebody with a bulbous bow gave results worse than those of the normal form over the whole speed range; which was not surprising, for it was well known that an appreciably favourable effect was not to be expected of a bulbous bow for speed/length ratios much smaller than 1·0. Though it was clear that, under ideal conditions, the differences in effective horse-power were insignificant, several ships with extremely V-shaped forebodies were known to suffer loss of speed, under bad weather conditions, much more than that experienced by normal ships of the same type. Much more information on that subject would become available as soon as the new sea-keeping laboratory of the N.S.M.B. was in full operation. He agreed with the author that not only the shape of the forebody, but also the longitudinal polar moment of inertia, played an important part in the sea-keeping properties of ships.

As to the afterbody, the experience of the N.S.M.B. was that the extreme U shapes had worse resistance properties than the corresponding moderate U shapes. Extremely V-shaped afterbodies always led to bad results. It was the experience of the N.S.M.B. that, to attain a high total propulsive efficiency in tank conditions, it was not necessary to use extreme U forms, either in the forebody or the afterbody.

MOST ECONOMIC SPEED

Dr. W. Muckle said that he had always been interested to know how a shipowner decided what size of ship to build, when he was considering a new one. One way of looking at the problem would be to assume that the shipowner had a certain capital sum to invest; how best could he invest it to get the best return on his money? That approach, however, might lead to a ship which could not be used to the best advantage in world trade. The author showed that, by increasing the speed from 14 to 15 knots, the cost was reduced by 0·5 per cent. per ton-mile. The curve as drawn showed quite a definite minimum point at 15 knots, but there was considerable possibility of variation of speed without any great increase in the cost per ton-mile. So many factors were involved that it was difficult to be definite in saying that 15 knots was exactly the speed for that particular type of ship.

On the question of cargo-handling appliances, it appeared that the author favoured the adoption of cranes rather than derricks; but cranes were probably more expensive than derricks. He mentioned the possibility of decreasing the resistance of the ship by say, 5 per cent. by means of model experiments. It was interesting to reflect that, by carrying out model experiments and improving ship form, the economics were improved without increasing the first cost to any great extent, whereas improved methods of cargo handling increased the first cost of the ship. Turning to structural arrangements, Dr. Muckle thought that there would be many more longitudinally-framed cargo ships built in the future. With welding there was a much greater initial deflection left in than with riveting, and longitudinal framing was a way out of that difficulty, apart from the economic aspects. There seemed no doubt that Dr. Corlett was correct in saying that the longitudinally-framed ship was much the more economical from the weight point of view.

He was interested in the author's suggestions for simplifying form from the constructional point of view. In his typical sections for a 10,000 ton tramp with developable hull form, it appeared that, from amidship to the sloping sides towards the ends, there must be some twist in the plates. Perhaps Dr. Corlett would comment on that. His two designs for the 11,000 ton tramp were very interesting. They were truly comparable, in that both had the same cargo deadweight, and therefore they represented the results that would follow an alteration in the service speeds, which were 12½ knots in the first and 15 knots in the second. It would be interesting to know how much the shipowner had to pay for that increase of speed, and to have comparative voyage estimates for some assumed voyage for the two ships, to see how they compared economically.

BEST USE OF SHIPS: MATERIALS FOR HATCH COVERS

Captain B. Lovricevic said that, as a master mariner, he would like to refer to Professor Silovic's remarks about the time spent in port, and to the statement in the paper that the choice of deadweight was a difficult one, as it did not depend upon a basic mathematical analysis. From the point of view of transport, a ship was best employed when she achieved the maximum of ton-miles—and that depended on the length of the voyage, on the time in port, the speed at sea and the deadweight capacity. He thought that some mathematical method might be devised for finding the optimum relationship between those four values. The optimum correlation thus obtained might not work satisfactorily when the ship was considered exclusively as a freight-earning unit, though a ship which was well employed from the technical point of view should give a good financial result. It would be worth while to know the optimum, however, for in any case it could be usefully applied as a guide.

Regarding the mechanically operated steel hatch covers: though no Yugoslav ship was equipped with them, they were determined to abandon wooden hatches, which wore out too soon and were a potential danger to the ship in bad weather and in the event of fire in the holds. They were reluctant, however, to use mechanical hatch covers consisting of lids with hinges, as the officers on board ships so equipped had reported rather unfavourably on them. They said that such hatches were a continuous source of trouble; also, in certain cases, it was necessary to reduce the length of the hatch in order to install them. He thought that steel or aluminium covers resembling pontoons, as used on American ships, provided a good solution to that problem, as with such an arrangement shifting beams and wooden hatch covers were not necessary.

Mr. C. F. Christensen found the paper of particular interest because in 1941 his firm had examined 116 ships, and from the reports on them they had designed a cargo vessel. The engines were aft and there was a raised tank top in No. 1 hold, and a low deep tank with hatches for the straight handling of cargo. The owners had not yet agreed to the use of electric cranes; but cranes would come, and would lead to further economies by reducing the time spent in port. For ordinary tramps, simplicity was a necessity. It was not easy to get experienced engineers; the cargo liners operating from the United Kingdom to three or four ports and then returning to the United Kingdom got the best. He thought that the paper did not give a true picture of the costs of the different types of main engines, because a heavy fuel oil installation cost up to £14,000 extra. There was also extra weight, and more maintenance was necessary, so that an extra man was required. His experience had been that there was more wear and that more spare parts were required.

On the structural side he entirely agreed with the author; they had longitudinal frames on the shelter deck and sides, the 'tweendeck and the double bottom; the remainder were transverse.

Mr. J. D. Calder said that he wished to pass on the comments of some of his Yugoslav friends who were too modest about their ability to speak English, one of whom had remarked what a relief it was to have a paper that was " full of meat " and which it was possible for him, with his limited knowledge of higher mathematics, to understand perfectly. It would be interesting to hear the views of a master mariner on the question of layout of accommodation. Perhaps Dr. Corlett would give his views on that point. Yugoslavia was still faced with the task of rebuilding the coastal fleet, and one or two questions had been put to him about the suggested designs for the 450 ton deadweight coaster and the 3,000 ton deadweight tramp. In the case of the coaster, there had been comments on the block coefficient of 0·675; and it seemed that the speed/length ratio with that block coefficient was rather unusual. Both ships represented types which had been built extensively in Yugoslavia since the war, and if Dr. Corlett could offer any comments they would be much appreciated.

SIMPLIFIED FORM

Mr. R. B. Shepheard, C.B.E., B.Sc., said that the author had dealt very constructively, under the sub-heading " Simplified Forms," with the possibilities of such easier forms from the construction and other points of view, referring particularly to the hull form of small ships. He would agree that a great deal of proved useful work was done in that sphere by the late Sir Amos Ayre during the war; perhaps some reference might be included to that useful and extremely valuable way of turning out sufficient ships under the stress of war conditions. In regard to structural arrangements and longitudinal framing, he entirely endorsed what Dr. Corlett had said. It had become increasingly obvious that, in cargo ships, longitudinal framing at the deck and at the bottom was the only right and proper form of construction. Mr. Shepheard said that because Dr. Muckle had suggested that the classification societies were only now beginning to appreciate the advantage of that form of construction; but he himself had been extremely interested in it for a number of years, and Lloyd's Register had done their best to experiment with scantlings and to influence the adoption of what was now becoming standard practice. In the arrangement of the machinery space for his 450 ton coaster, Dr. Corlett seemed to have made the best possible use of the space aft, but there might be difficulties in respect of ventilation and access to the main engine. With regard to ballasting, there was an adequate forepeak, but apparently no water-

ballast capacity right aft. No doubt Dr. Corlett had looked into that carefully, but Mr. Shepheard wondered whether the ballast draught, particularly aft, would be adequate when the ships was light.

Captain Lovricevic had referred to the type of steel hatch covers described in the paper. In the design of small ships the disadvantage of having large covers, split into two and spread fore and aft, was quite emphatic. It meant that, in such ships, where large hatches were particularly useful, there was inevitably some restriction in the length of the hatches, which would not arise if the pontoon type of steel cover were used. He had hoped for more comment on the designs for the 11,000 ton slow and fast tramp ships, in relation to their accommodation, and from the seaman's point of view. He also asked if Dr. Corlett had any comments to make on visibility and operation generally, with the bridge placed aft. When the ship was light and in ballast, was he satisfied that there was good visibility over the forecastle head?

Mr. A. Augustin-Normand said that, in France, he had been using free-piston engines in dredgers, and in two small cargo ships of 900 tons, running between Bordeaux and Hamburg; they had covered so far about 6,000 miles. The engines could use all sorts of oil fuel; in the United States they had used the worst fuel they could find, and the engines were still very successful. At the next meeting of the Institution, he might be able to offer a paper about them.

AUTHOR'S REPLY

Dr. Corlett, replying to the discussion, said that he greatly appreciated the constructive comments on his paper and thought that some of the information elicited would be useful to those who actually had to produce ships of the type described.

Professor Silovic had mentioned coupled derricks; it was certainly a point that one man should be in complete control of the entire operation. He also spoke of engines of 8,000 to 10,000 h.p., but there he was getting out of the tramp ship range and into that of the cargo liner. Recently he had had to cost installations giving approximately 10,000 s.h.p., and his experience was that there was little to choose between the costs of Diesel machinery and of steam turbines; but admittedly to get reasonable fuel consumption, they were using advanced steam conditions in the turbines. Mr. Mitchell asked if he had any experience of heavy lifts in tramps. He had had something to do with 150 ton lifts, but was not in a position to give any information. He did not think that any tramp-ship owner would contemplate using the gas turbine within the next decade.

In reply to Dr. Muckle, he thought that many shipowners worked in an *ad hoc* way in deciding what to have. Sometimes they had a certain sum of money available, but they seemed to decide mainly upon their own feelings rather than on any detailed analysis of the size and speed of ship they should have. He would not say that that applied to all shipowners, but some did work on those lines. Dr. Muckle's interpretation of Fig. 4, showing the relative cost per ton-mile for different speeds for a modern Diesel ship burning boiler oil, was correct; there would be little disadvantage for that particular ship in operating at speeds between 14½ and 15½ knots. He did not recommend in the paper that tank tests should not be carried out; if it was possible to save by experiments in the tank, obviously they would do so. What he deprecated was that less importance should be attached to the cargo-handling aspect of ships' economics. With regard to developable forms, Dr. Muckle suggested that there should not be a twist in the plating in coming from the straight side to the conical stern. In point of fact, the junction between the flat side and the conical stern would not lie along a section at right angles to the ship's axis; it would be at an angle probably of 40 deg. or so from the horizontal.

He was most interested in the remarks by Captain Lovricevic, and entirely agreed that the deadweight choice was available by computation; but that applied more and more to ships which had regular voyages. It was very difficult for the owner of a tramp ship to say what she would do during the next 20 years, and as a result a considerable amount of guesswork and intuition was involved.

Mr. Christensen had spoken of the ship he designed in 1941. That was a classic case, a very fast cargo liner, and great efforts were made to enable her to reduce the time spent in port. She was equipped with magnificent cranes. The problem of getting good engineers for service on tramps, also mentioned by Mr. Christensen, was very serious. Some owners were using triple-expansion steam-engined tramps because, they said, they could not get good engineers. It was a world-wide problem, particularly troublesome in Britain and, of course, almost prohibitive in America. Accommodation had been improved and improved, and still they could not get the engineers; but it would seem a very retrograde policy to build ships which were of proved lower efficiency because good engineers could not be obtained. Something must be done to get good engineers rather than build less efficient ships.

The problem of visibility and navigation when the navigation houses were placed aft had worried many people; but there was a Swedish 24,000 ton tanker in service with the bridge aft, and she was quite efficient. The matter seemed to be largely one of opinion. With regard to the suggested designs for a 450 ton and a 3,000 ton tramp, the small ship was a coaster and her power was based on North Sea and sheltered-water conditions. Mr. Shepheard had suggested that the engine room was congested, and so it was; hence the effort to reduce the size of the engine to a minimum. There must be accessibility for maintenance, and power ventilation was necessary. About the layout of the accommodation aft: the designs of the two 11,000 ton ships were related to ships which had been built. In the case of the 12½ knot ship, the owner made the particular point that he wished to segregate all the accommodation, having experienced trouble in some ports due to shore personnel coming on board; there were complaints from the crews. The compact arrangement shown was an attempt to cover the requirements. The ballasting arrangements for both ships was intended to minimise the problem of poor visibility over the forecastle in the ballast condition. It should be possible to trim the ship reasonably well. There was no doubt, however, that opinion was divided, and, of the designs for such ships, about half showed the houses aft, and half amidships.

SOCIAL EVENTS AND VISITS

The presentation and discussion of Dr. Corlett's paper concluded the technical sessions of the meeting. While they were proceeding, on September 21, parties of the ladies were visiting Kraljevica and Crikvenica, and various social institutions in Rijeka. In the evening, the members and their ladies were the guests of the Yugoslav Society of Naval Architects at an informal dinner in Opatija, which was followed by an exhibition of folk dancing. Professor Silovic, welcoming the guests, said that it was the first time that the Yugoslav naval architects had tried to organise such a function; they had supposed it to be as simple a process as designing a ship, but had found it otherwise in practice. He concluded by urging the members of the Institution's party, in the course of their tours in Yugoslavia, to " Keep your eyes open and don't be afraid to ask questions "—an invitation which may be said to reflect the whole spirit of the meeting. Sir Harold Yarrow and Mr. R. B. Shepheard were warmly supported when they expressed the thanks of the Institution for the hospitality extended to the members and their ladies. The dinner and entertainment were followed by a dance.

On the following morning a visit was paid to the " May 3rd " shipyard at Rijeka, the ladies meanwhile visiting the remarkable caves at Postojna, stated to be the largest in Europe. At the shipyard, the members were received by the Technical Director and other officials, and by members of the Executive Committee, and were afforded every opportunity to see the various departments and to appreciate the work involved in restoring the yard to production after the war, in the course of which it had been largely destroyed.

In the evening, the members and ladies joined again, to embark in the steamer Partizanka for a voyage of 2½ days duration down the Dalmatian coast. The Partizanka, a vessel of some 1,730 tons, was built on Tyneside in 1931 by Messrs. Swan, Hunter and Wigham Richardson, Limited, and was originally named Prestolonaslednik Petar. Her twin-screw quadruple-expansion engines were constructed by Plenty and Son, Limited, Newbury. Early in the war she struck a mine and sank in some 66 fathoms, remaining there for nearly ten years. She was salved by the use of camels, a feat of peculiar difficulty in view of the depth at which she lay, and the fact that there was practically no tidal lift to assist in raising her. The Yugoslav naval architect responsible, Ing. Ivan Fabrio, accompanied the party on the cruise, and his description of the work of salvage added considerably to its interest.

In the course of the trip, calls were made at the island of Korcula, where shipbuilding in wood is still practised; at Gruz, the harbour of Dubrovnik, whence sightseeing tours were organised to that ancient Dalmatian stronghold; at Split, of equal historic interest and the location of one of the principal shipyards in the country; and at Sibenik, another historic port. The shipyard at Split had been destroyed almost more thoroughly than that at Rijeka, and its re-equipment is still not entirely completed; but enough could be seen to enable the members to appreciate the extent of the re-organisation described in the paper upon it, by Mr. M. Stanger and Mr. S. Ercegovic, which they had heard three days earlier.

THE ZAGREB SHIP-MODEL ESTABLISHMENT

The return of the Partizanka to Rijeka, on the morning of September 25, concluded the programme as it was originally arranged, most of the party returning thence to England; but a small number were able to take advantage of the invitation extended to them, to visit the new ship-model testing tanks now being built at Zagreb, which they inspected under the guidance of Professor Silovic and of Dipl. Ing. V. A. Sentic, of the Brodarski Institut, the superintendent of the establishment. The constructional work is still some way from completion, only one tank being in use at present; but eventually there will be three, in addition to a large circular tank for steering tests. The tank that is in use, which is fitted with a Kempf and Remmers carriage, capable of a speed of 3 m. per second, is 3 m. wide and 2½ m. deep, and at present is 37 m. long. In due course its length will be extended to 60 m. to enter the steering tank (37 m. in diameter) at a tangent. Models can then be taken at speed down the straight tank and released to run freely in the steering tank, which is of the same depth as the straight tank. The other two tanks, still under construction, comprise a deep tank 270 m. long, 12 m. wide and 6½ m. deep, which will have a carriage with a maximum speed of 10 m. per second; and a high-speed tank 300 m. long, 5 m. wide and 3 m. deep, to be provided with a carriage capable of travelling at 20 m. per second. All three tanks will be fitted with wave-making apparatus. An administrative building, of notably attractive design, is already in occupation, and work is proceeding on various workshops and on housing for the staff; the latter necessitated by the situation of the establishment in open country, at some distance from the city of Zagreb. It may be remarked that the road in which the houses stand is named after William Froude; a distinction which, so far as we are aware, has not been accorded to him before, even in his native England.

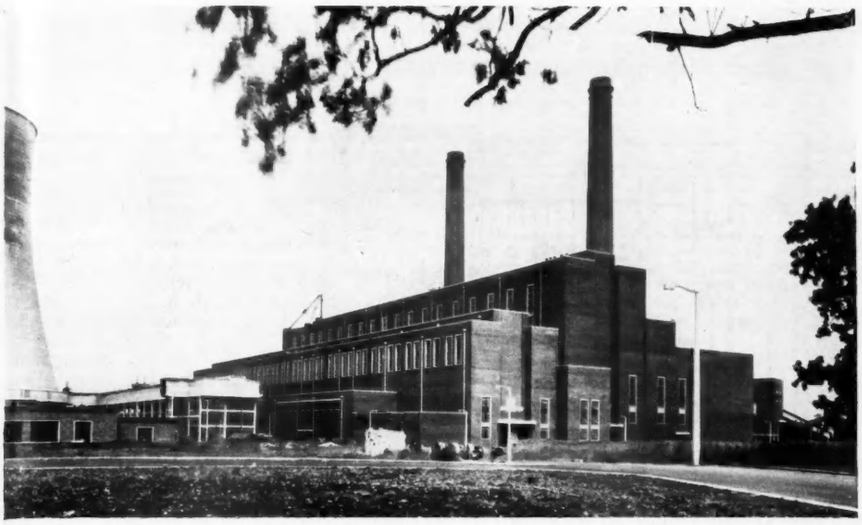


Fig. 1 Exterior of the 240 MW Drakelow A power station, near Burton-on-Trent, from the south-east.

POWER STATION WITH ADVANCED STEAM CONDITIONS

240 MW PLANT AT DRAKELOW

The 240MW power station at Drakelow, near Burton-on-Trent, which was formally opened by Mr. J. Eccles, deputy chairman (operation), Central Electricity Authority, on Friday, October 21, is of special interest since it is equipped with boilers each of which is capable of generating 515,000 lb. of steam per hour at a pressure of 1,550 lb. per square inch and a temperature of 1,060 deg. F. from pulverised Midland coal of low grade. These advanced conditions have considerably influenced the design of the steam raising plant, the turbines and the associated pipe-work, as will be gathered from the description given below. The layout is on the unit system, i.e., one boiler to each turbo-alternator, and the boilers have been constructed so that only on-load cleaning will be necessary during periods up to 14 months. The machines are suitable for two-shift operation, although they will usually be employed on base load, which requires three-shift operation. Complete instrumentation is provided in order to obtain detailed operating results. An external view of the station, which is situated in park-like surroundings, appears in Fig. 1.

Coal from the local mines can be brought in either by rail or road. Rail-borne coal is handled by plant consisting of two sets of duplicate tipplers, one for each pair of boilers, and a series of electrically-driven gravity bucket and belt conveyors, which discharge either to the boiler-house bunkers or to the store, the total capacity of the system being 480 tons per hour. The tipplers are designed to handle 24 ton railway wagons, but alternatively road vehicles or 40 ton wagons can be discharged into a receiving hopper and thence on to conveyors, which are connected to the rest of the system. The store has a capacity of 56,000 tons and is equipped with a transporter bridge which is capable of dealing with 240 tons of coal per hour. The main contractors for this part of the plant were Mitchell Engineering, Limited, 1 Bedford-square, London, W.C.1, and the driving motors were manufactured by Laurence, Scott and Electromotors, Limited, Norwich.

STEAM-RAISING PLANT

The four boilers which will comprise the steam-raising plant at Drakelow A are the first example of the advanced operating conditions which have recently been adopted by the Central Electricity Authority. Each boiler with its associated equipment is designed to evaporate 515,000 lb. of steam per hour at a pressure of 1,550 lb. per square inch and a temperature of 1,060 deg. F., and to supply a single 60 MW turbo-alternator on the unit system. This part of the equipment, for which International Combustion, Limited, 19 Woburn-place, London, W.C.1, were the principal contractors, is based on the use of low-grade Midland fuels with a gross calorific value of 8,770 B.Th.U. per pound, an ash content of 21·5 per cent. and a moisture content of 14 per cent. The ash fusion temperature—2,075 deg. F. in a reducing atmosphere—is low; and this, combined with the high steam temperature, necessitated careful consideration being given to the furnace design in order to fulfil the specified condition that continuous operation with only on-load cleaning should be possible for periods up to 14 months. The plant had also to be suitable for two-shift operation.

The arrangement of one of these units will be clear from the sectional drawing given in Fig. 2, while Fig. 3 shows a boiler in course of construction.

The layout has enabled the pulverisers to be arranged in lines alongside their respective boilers and this, in turn, has led to a neat and economical arrangement of the coal handling plant mentioned above. The four Lopulco pulverisers for each boiler, to which coal is delivered from the bunkers, are driven by 185 h.p. Trislot motors, manufactured by Laurence, Scott and Electromotors, Limited, and are swept by Keith Blackman exhausters a view of which is given in Fig. 4. These pulverisers supply fuel to a burner nozzle in each corner of the boiler, the arrangement being such that there is tangential firing to an imaginary circle at the centre of the combustion chamber. The four nozzles in any one corner are mounted vertically one above another in a single casing and are coupled together so that they are tilted simultaneously by a Kent steam temperature controller. Two Wallsend Slipway pressure-type oil burners are also fitted in each casing, the total capacity of which is sufficient to raise up to 80,000 lb. of steam per hour on oil alone. When firing the coal specified the maximum continuous load can be carried with three pulverisers in service and the maximum continuous rating can be obtained with coal with a moisture content as high as 25 per cent.

BOILER CONSTRUCTION

The boilers, the construction of which is shown in the drawing Fig. 2, were built by International Combustion, Limited, and are of that firm's three-drum radiant type. The combustion chamber, the volume of which is 34,900 cub. ft., is completely water-cooled by close pitched bare tubes on the side walls and by finned tubes on the front and rear walls and roof. In order to attain the final high steam temperature there is, however, no water-cooled screen between the front and rear walls before the superheater.

The hollow-forged steel drums, which were supplied by the English Steel Corporation, Limited, Sheffield. 9, comprise a steam drum 34 ft. long, 5 ft. internal diameter and 5⅝ in. thick with a finished machined weight of 67¼ tons. The feed drum is of the same length and diameter, but is 5 in. thick and weighs 60 tons. The mud drum is 28 ft. long, 2 ft. 6 in. in internal diameter and 2½ in. thick, its finished weight being 12¼ tons.

Each boiler has a radiant heating surface of 8,800 sq. ft. and a convection heating surface of 3,565 sq. ft. The heat release in the combustion chamber is 19,150 B.Th.U. per cubic foot per hour at the maximum continuous rating.

Feed water at a temperature of 430 deg. F. passes through twin Heenan all-welded economisers with a total heating surface of 39,168 sq. ft., which were manufactured by Senior Economisers, Limited, Southampton-row, London, W.C.1. It enters the feed drum at the rear of the boiler through multiple risers. Cool water for the furnace walls is drawn from this drum through 3 in. downcomers to the "mud" drum and through 5 in. pipes from this drum to the various wall headers. The risers from the side walls discharge into the front drum, the steam being delivered thence into the feed drum through three rows of tubes with an external diameter of 3 in.

SUPERHEATER

The gases leave the furnace through a specially designed exit channel which screens the high-temperature sections of the Melesco superheater from direct radiation from the combustion zone. This superheater, which was constructed by the Superheater Company, Limited, 53 Haymarket, London, S.W.1, is built up in five stages which are arranged in series; three, the heating surface of which is 29,500 sq. ft., being in the low temperature and two, with a heating surface of 5,450 sq. ft., in the high temperature zone. The elements of the first two low-temperature stages are made of hot-rolled mild-steel tube, those of the third stage are of chromium-molybdenum steel and those in the two high-temperature stages of 18/8 chromium-nickel steel.

The high-temperature stages are of the pendant type and the sections are widely spaced. The gases traversing them are cooled below the ash fusion temperature and pass vertically downwards through the low-pressure stages, which are arranged horizontally. After traversing a small amount of convective heating surface they are then withdrawn through the economisers and through parallel circuits each consisting of a Ljungstrom regenerator air heater and an electrostatic precipitator by the induced-draught fans. The gases are finally discharged into a 360 ft. chimney.

The air heaters, the total heating surface of which is 124,000 sq. ft., were manufactured by James Howden and Company (Land), Limited, 195 Scotland-street, Glasgow, C.2. They consist of a regenerator through one half of which the gas flows and through the other half of which the air passes before entering the furnace. The regenerator revolves slowly so that the heating elements pass through the stream of hot flue gases and the cold air. This air is supplied by two forced-draught fans, which were manufactured by Davidson and Company, Limited, Belfast, and each of which has an output of 77,500 cub. ft. of air per minute. It is driven

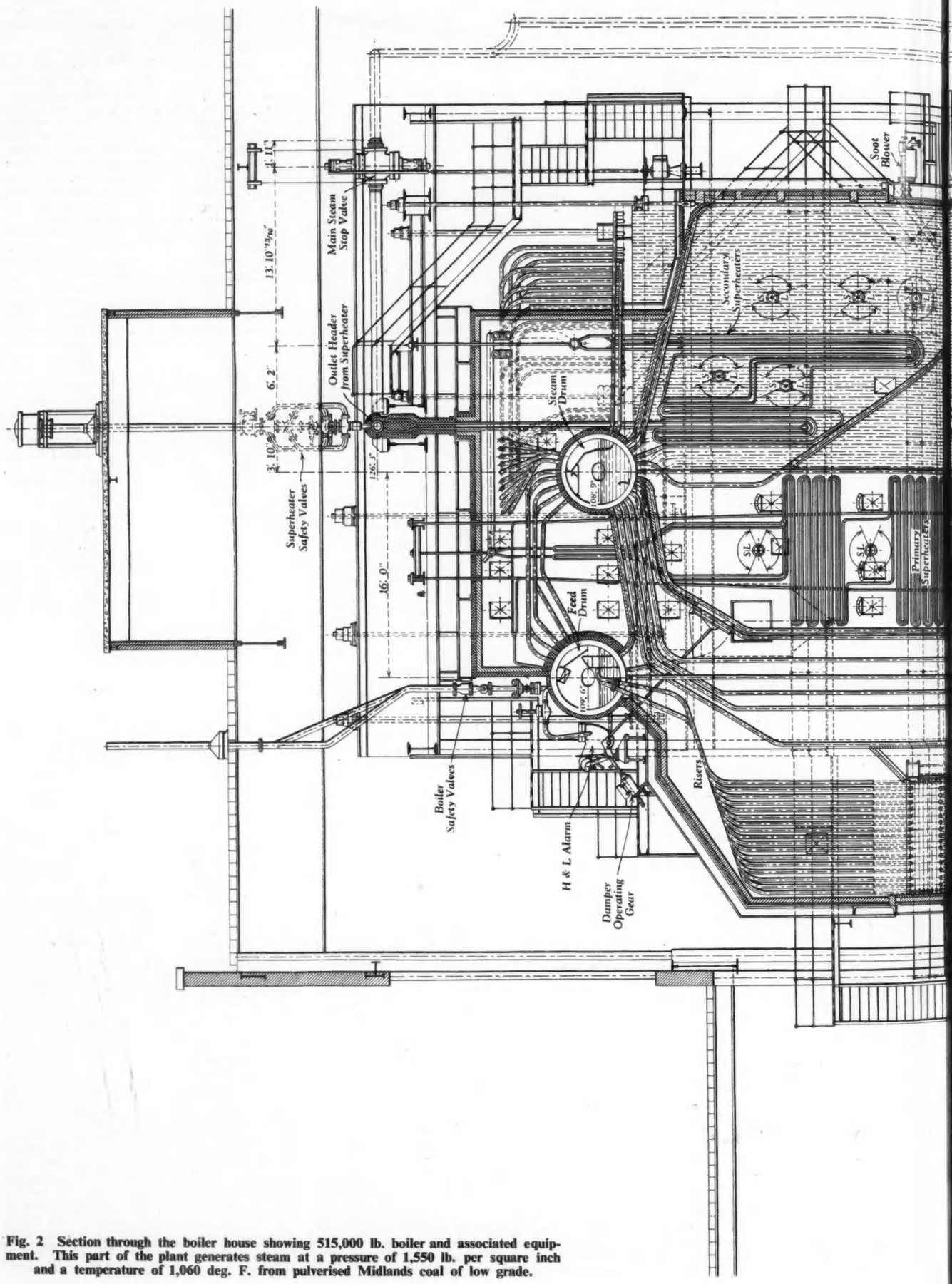
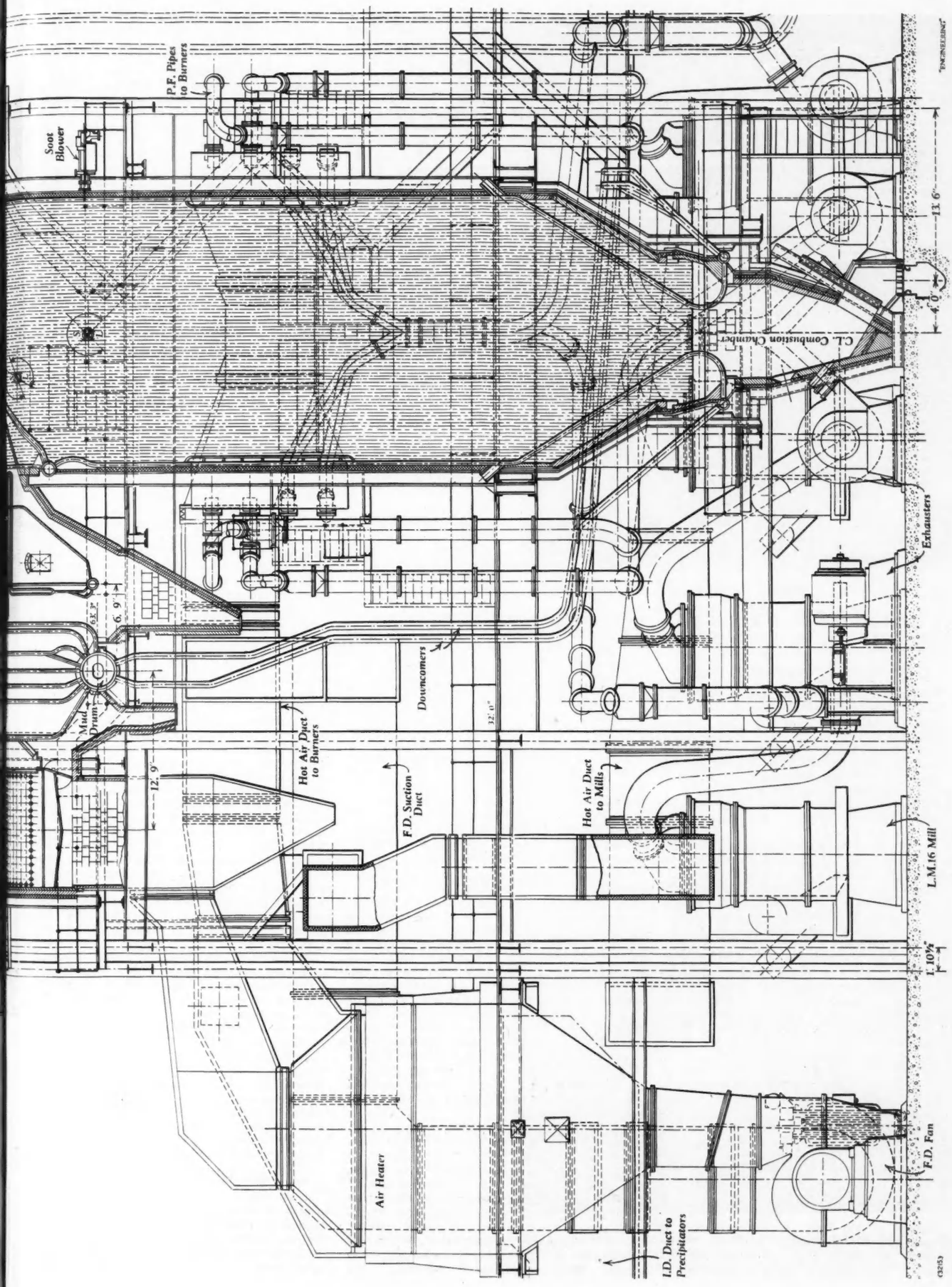


Fig. 2 Section through the boiler house showing 515,000 lb. boiler and associated equipment. This part of the plant generates steam at a pressure of 1,550 lb. per square inch and a temperature of 1,060 deg. F. from pulverised Midlands coal of low grade.


P.F. Pipes to Burners
Soot Blower
C.L. Combustion Chamber
13' 6"
4' 0"
Exhausters
Primary Superheater
6ft 3"
6' 9"
Mud Drum
Downcomers
12' 0"
Hot Air Duct to Burners
F.D. Suction Duct
Hot Air Duct to Mills
12' 9"
L.M.16 Mill
1' 10½"
Air Heater
F.D. Fan
I.D. Duct to Precipitators
"ENGINEERING"

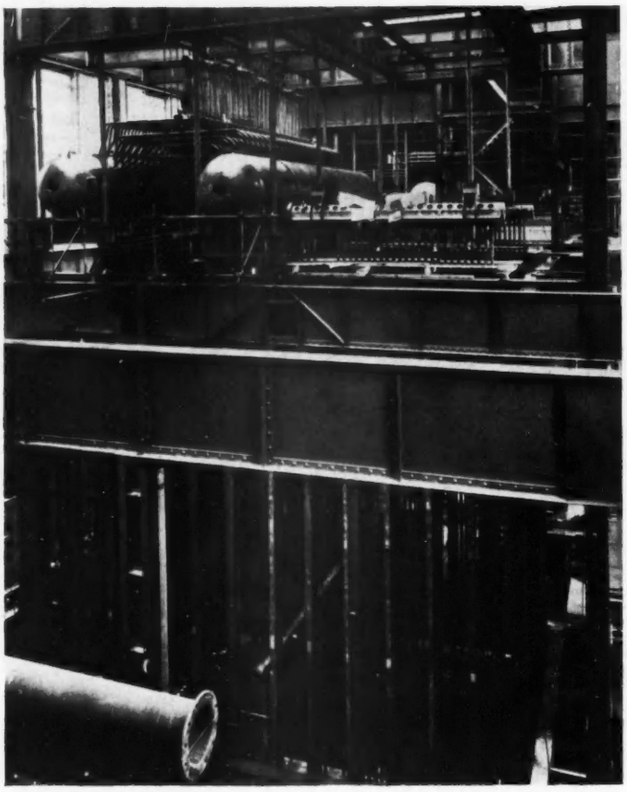


Fig. 3 One of the 515,000 lb. per hour boilers under construction.

by a 230/25 h.p. variable-speed alternating-current motor manufactured by Laurence, Scott and Electromotors, Limited.

ELECTROSTATIC PRECIPITATORS

The electrostatic precipitators, which were installed by the Sturtevant Engineering Company, Limited, Cannon-street, London, E.C.4, consist of a treatment zone through which the dust-laden gases from the air heaters pass and where they are exposed to the high potential difference which is maintained between discharge and receiving electrodes. The solid matter is thus driven to the tube walls and the clean gases pass out through damper-controlled outlet ports to the main flue.

Tapping gear is provided to maintain the tubes and electrodes in a clean state and the precipitated dust is discharged into hoppers from which it is ejected on to a conveyor and thence into the ash chute. Power is obtained from three interconnected sets of high-tension equipment, one for each precipitator, with the third as a stand-by. Each set includes a mechanical rectifier, which generates the high-tension uni-directional current required for cleaning, and its associated transformer and voltage regulator.

The two induced-draught fans with which each boiler is equipped, were also manufactured by Davidson and Company, Limited, and are of that firm's double-inlet radial tipped blade type. They have an output of 120,000 cub. ft. of air per minute and are driven by Laurence, Scott 495/31 h.p. alternating-current motors at a speed of 847 to 328 r.p.m., These variable-speed commutator motors driving the fans, as well as the forced-draught fans, coal feeders and mill classifiers, are fitted with induction regulators, alterations in the position of which are effected from the control panel by a pilot motor.

STEAM TEMPERATURE CONTROL

Control of the final steam temperature is effected automatically within $\pm$ 10 deg. F. by altering the vertical angle of tilt of the fuel burners. The resultant raising or lowering of the flame mass reduces or increases the furnace cooling surface presented to the gases and thus maintains the exit temperature of the gases at the necessary figure for the boiler load. The operation of the burner nozzles for this purpose is performed by pneumatic cylinders, which are actuated by a Multelec steam temperature recorder supplied by Kent and Company, Limited, Luton. Coarse control of the temperature, to maintain it within the operating limits of the tilting equipment, is effected by a manually-controlled power-actuated damper, so that a proportion of the gases is by-passed round the low-temperature stages of the superheater.

The furnace draught is maintained constant by control gear manufactured by Bailey Meters and Controls, Limited, Progress Way, Purley Way, Croydon, which automatically controls the speed of the induced draught fan. The boiler water level is maintained steady by a Cope system which incorporates thermostats on the drum and a "Flowmatic" diaphragm, on either side of which the steam pressure is applied from the secondary superheater inlets and outlets. This enables two Gordon Anderson valves with variable port openings, and fitted with a pressure compensating device, to be used to control the supply of feed water to the boilers.

The onerous availability requirements have necessitated a close consideration of the soot-blowing arrangements. As a result, eight retractable and two lance-type blowers have been installed in each combustion chamber, 12 lance-type blowers in the superheater passes, four traversing blowers in each economiser and four multi-nozzle blowers in each air heater. All these blowers, which were supplied by the Ivor Power Speciality Company, Limited, 29 Woburn-place, London, W.C.1, are electrically operated and automatically controlled.

ASH HANDLING

Ash from the boiler hoppers and dust from the electrostatic precipitators are discharged at intervals into a basement-level hydraulic sluicing system and are thence conveyed by gravity to swirl pits. The ash and dust bearing water is pumped from these pits by three 100 per cent. duty electrically-driven vertical spindle pumps each with a capacity of 3,300 gallons per minute and is discharged by a gravity-fall overhead launder, which is of ferro-concrete construction and is lined with basalt tiles, to a disposal ground in the loop of the river about half a mile distant. The main contractors for this part of the plant were International Combustion, Limited; the pumps were supplied by Gwynnes Pumps, Limited, Lincoln.

JOINING FERRITIC AND AUSTENITIC STEEL PIPES

As the steam pressure at the boiler stop-valve is 1,550 lb. per square inch and the temperature 1,060 deg. F., careful consideration had to be given to the type of material used for the main connecting pipes. It was eventually decided to utilise "Staybright" stainless steel, F.C.B. (T) quality, for this purpose and to employ butt-welded joints, which were radiographically inspected. As this austenitic steel has a comparatively low creep rate and the high-pressure cylinder of the turbine is of ferritic steel it was, however, impossible to weld the two together owing to the difference in thermal expansion between the two materials. A transition piece, consisting of a composite casting, one end of which was austenitic and the other ferritic, was therefore interposed between the two.

To counteract the different coefficients of expansion when this casting is subjected to cyclic temperature variations, each transition piece is provided with an electric heater, which is brought into service when a set is shut down so that its temperature is maintained at a pre-determined level. These heaters will, however, only be used when the shut-downs are relatively short; for longer periods the transition piece will be allowed to cool to the ambient temperature and pass through the cyclic variation. There is a recording and control panel for each unit.

This arrangement necessitated considerable research by the manufacturers—Aiton and Company, Limited, Derby—in order to develop new techniques both for operations performed at the works and for the welding processes on site.

TURBINE DESIGN

The two 60 MW 3,000 r.p.m. generating sets at present installed each consist of a three-cylinder, tandem compound turbine with a double-flow low-pressure cylinder exhausting to twin condensers. These sets, which were constructed by the English Electric Company, Limited, Kingsway, London, W.C.2, are arranged longitudinally down the turbine room, as shown in Fig. 5, with no dividing wall between them and the unit boilers. With the designed conditions of 1,500 lb. per square inch and 1,050 deg. F. at the turbine stop-valve and a vacuum of 28·75 in. at the condenser they have an estimated consumption of 475,000 lb. of steam per hour at full load.

The high-pressure cylinder of each turbine contains a Curtis wheel and ten pressure-compounded impulse stages; the intermediate-pressure cylinder 19 impulse stages; and the low-pressure cylinder two impulse and 14 reaction stages. The last two rows of blades in the low-pressure cylinder are provided with Stellite shields to delay the effects of erosion by condensed water droplets in the exhaust steam. The low-pressure exhaust end of the machine is protected both by an atmospheric valve and a rupturing diaphragm. The glands are packed with steam from an auxiliary range on starting. After a load of 10 MW has been reached, however, a supply for this purpose is obtained from bled steam. The turbine is protected by a vacuum unloader and a low vacuum trip, which operates on both the electrical and steam sides. Two separate steam chests are mounted alongside each set and contain the governor valves and an emergency stop-valve. All these valves are operated by oil, which is supplied from a pump driven from the turbine shaft.

The turbines are provided with a complete set of supervisory equipment. Two instruments indicate the relative positions of the shafts and cylinders on both the high-pressure and intermediate pressure sections. In addition, shaft eccentricities on both the high and intermediate pressure cylinders are indicated and recorded, while further instruments on the control panel, which is situated near its associated turbine, show the throttle opening, turbine speed, movement of the high-pressure cylinder, and vibration. It is considered that this wide degree of instrumentation is necessary on turbines operating under the conditions of temperature and pressure present at Drakelow.

FEED-HEATING SYSTEM

Steam from the exhaust of the low-pressure turbine cylinder is discharged into twin condensers of Worthington-Simpson manufacture, the total cooling surface of which is 55,000 sq. ft. These condensers, which are of the regenerative type, are designed to handle 354,000 lb. of steam

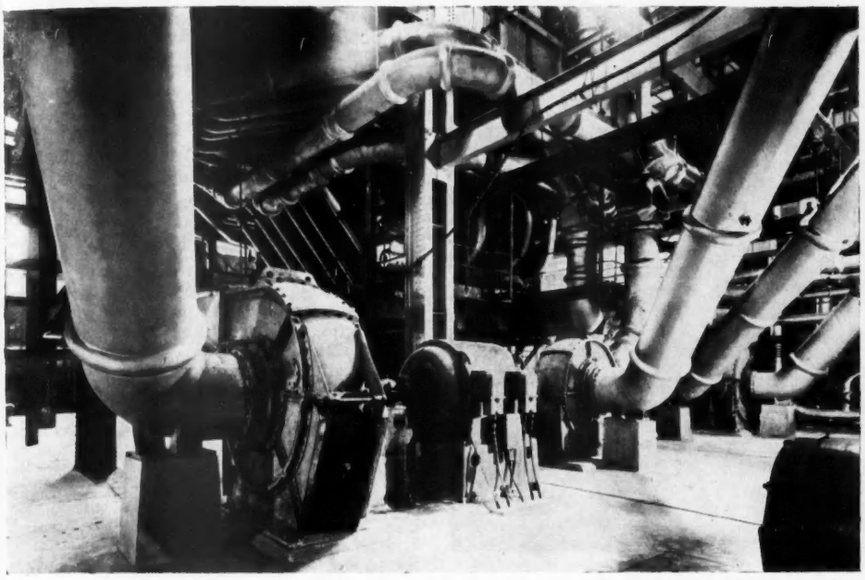


Fig. 4 The boiler-house basement, showing the exhausters.

per hour. The circulating water is arranged to flow through them twice, first passing along the bottom half of the tubes and then back through the top half to the inlet culvert of the cooling tower. About 32,600 gallons of water per minute are required for this purpose on full load and with this flow and load the temperature rise is about 17·5 deg. F. Water is supplied by any two of three 50 per cent. duty pumps, each of which has an output of 16,300 gallons per minute. These pumps, which are also of Worthington-Simpson manufacture, are driven by 455/195 h.p. 3·3 kV two-speed squirrel-cage English Electric motors, the low speed being employed when they are discharging to the river and the high speed when the cooling tower is being used.

The condensers are drained by two 100 per cent. duty electrically-driven extraction pumps, which discharge through two low-pressure feed-water heaters (one of which is a de-aerator) and thence to the feed pump suction main. Air is extracted by three 50 per cent. duty two-stage steam jet operated ejectors. There are two 100 per cent. duty Weir feed pumps for each boiler, the individual outputs of which are 515,000 lb. per hour at a pressure of 2,120 lb. per square inch. These pumps, which are driven by constant-speed motors, discharge through four high-pressure heaters to the boilers, the temperature of the water at the economiser inlet being 430 deg. F. Each feed heater, which is of Worthington-Simpson manufacture, is supplied with steam bled from the turbine and is provided with an automatic anti-flooding device, thus enabling it to be isolated on the steam side and by-passed on the water side.

To permit the turbine to be supplied at a suitable temperature when running up, a "dumping" system has been installed so that a large quantity of steam can be supplied to the superheaters and raised to an adequate temperature before reaching the set.

COOLING WATER

Cooling water up to a maximum of 8 million gallons per hour is obtainable from the River Trent, but this will have to be supplemented during the summer by cooling towers, one of which, with a capacity of 3,820,000 gallons of water per hour, has now been erected by Mitchell Construction Company, Limited, Peterborough. It is of ferro-concrete construction and is 300 ft. high above the pond coping.

Water is drawn from the river through Brackett cup-type screens by three vertical-spindle two-speed centrifugal pumps for each set. These pumps were manufactured by Drysdale and Company, Limited, Glasgow, and have individual outputs of 16,300 gallons per minute against a normal working head to the river of 28 ft. and of 67 ft. to the cooling tower. They are electrically driven by 525 h.p. motors, manufactured by Laurence, Scott and Electromotors, Limited, and are installed in a pump house on the river bank, a distance of some 750 yards. The water is delivered to the station through twin concrete culverts, provided by Aiton and Company, Limited, Derby, and is discharged to the cooling tower pond and conduit system, penstocks being provided so that either direct or mixed cooling can be employed, depending on the river flow.

To minimise organic growth in the condenser tubes and to obtain optimum vacuum conditions without having to resort to frequent off-load cleaning, an intermittent de-sliming equipment has been installed. This injects a concentrated solution of chlorine into each of the circulating-water suction pipes in sequence.

HYDROGEN COOLING

The hydrogen-cooled alternators, which are of English Electric manufacture and to which the turbines are directly coupled, generate three-phase current at 11·8 kV. They are rated at 60 MW and a power factor of 0·8 when operating at a gas pressure of 0·5 lb. per square inch. The hydrogen is supplied from cylinders which are connected to a manifold at basement level, where the associated control and seal oil equipment is also installed. The system controlling the supply automatically maintains the density and pressure of the gas within the machines, any deviation being indicated by alarms. Purging is effected by carbon dioxide, which is removed from the casing by compressed air before access to it can be gained.

The alternators are excited by separate motor-driven machines which operate in conjunction with automatic voltage regulators of the normally inactive type. Protection against under-excitation is ensured by equipment, which is brought into operation when a pre-determined stability margin is approached. The stand-by exciter, which is installed in the station, is also arranged to provide current for rapidly charging two 800-ampere hour batteries which are normally automatically float-charged from two 20 kW mercury arc rectifiers.

The hydrogen cooling system is connected to two pumps each with a capacity of 650 gallons per minute, which draw water from the same suction pipe as the circulating water pumps. These pumps are also used to supply cooling water to the coolers for the bearings of the cooling water pumps, the air coolers of the boiler feed pump bearings and glands, and the heater drain pump bearings.

132 kV SWITCHGEAR

The alternators are solidly connected to 72 MVA, 11·8/141·6 kV English Electric transformers. The high-tension sides of these transformers are connected to an outdoor switching station, a view of which is given in Fig. 6. This is equipped with 15 air-blast circuit-breakers with a rupturing capacity of 3,500 MVA, which were manufactured by A. Reyrolle and Company, Limited. Each circuit-breaker consists of three single-phase units and each single-phase unit comprises four air-blast turbulator type interrupters. These interrupters are connected in series electrically and are mounted one above the other, the whole carried on a welded bedplate.

Each interrupter consists of a moving side contact, which is fitted with main current-carrying and arc-initiating contacts. The moving side contacts are mounted on spring-loaded pistons, which move laterally when the air pressure rises to a pre-determined value. When the blast pressure is removed the contacts are rapidly returned to the closed position by springs. The voltage distribution during breaking is controlled by tubular capacitors of Bakelised paper, which are built into each interrupter and also serve to conduct the blast

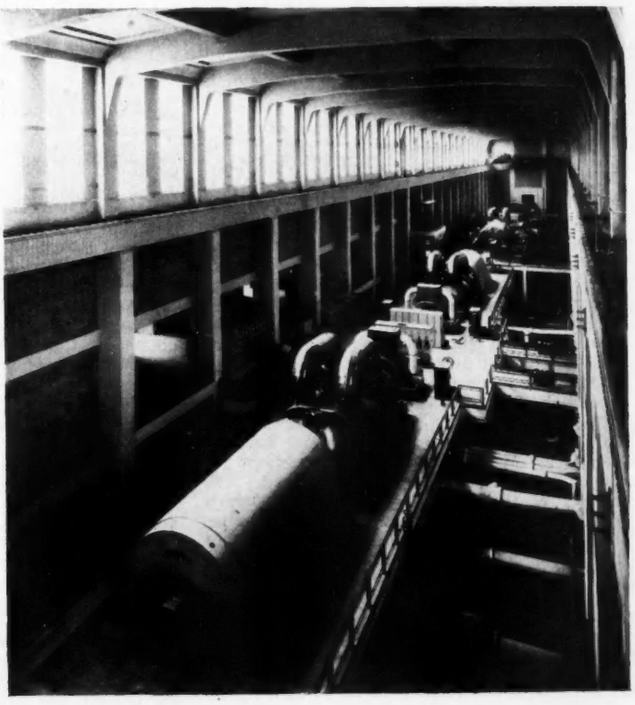


Fig. 5 A view in the turbine room showing the arrangement of the 60 MW sets with the steam ends adjacent. This has led to an economical layout of both the pulverisers and the coal-handling plant.

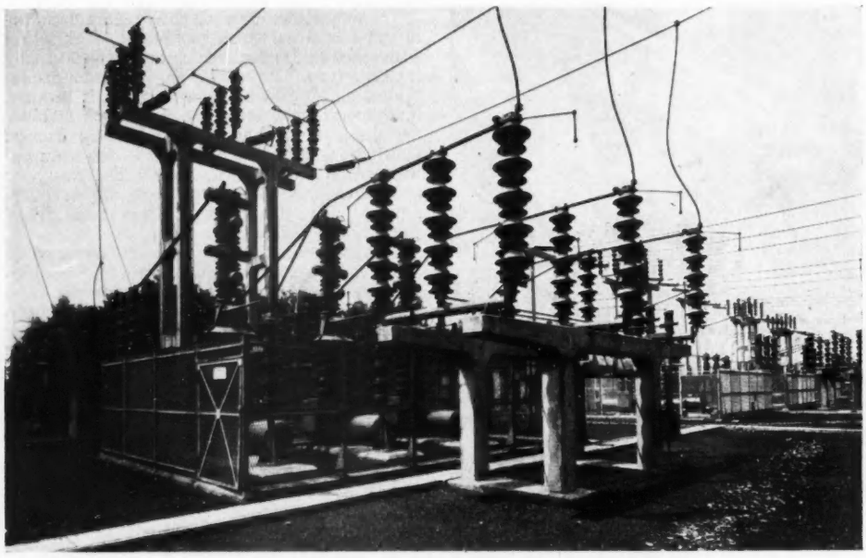


Fig. 6 The 132 kV switching station, equipped with 3,500 MVA air-blast circuit-breakers.

of air to the moving contacts. The circuit-breaking and exhaust chambers are totally enclosed and weatherproof and are fitted with the spring-loaded valves, which allow the blast air to exhaust to atmosphere during an opening operation.

Isolation is effected by an Isomaker, which is a combined isolator and making switch. It is coupled to a vertical insulating torque shaft alongside the pedestal structure by a swash-plate mechanism, the fixed contact being mounted on an insulating post or current transformer.

OPERATING ARRANGEMENTS

Each single-phase unit is provided with a separate local air receiver, which can be isolated from the main air system. The three receivers on each three-phase breaker are inter-connected. Each single-phase unit also incorporates a three-stage electro-pneumatic trip valve, which controls the opening of three blast valves; these valves being mechanically coupled and driven by an air motor. When the trip coil is energised it actuates the first stage of the trip valve so that high-pressure air opens the second and third stages and finally operates the piston of the air motor. The air motor, in turn, operates the blast valve, so that air is supplied to the blast pipe and the circuit-breaker proper. The build-up of air pressure in the circuit-breaker chamber drives back the side contact piston, so that an arc is drawn between the arcing fingers of the moving contact and the top of the lower arcing electrode. The stream of air moves the arc so that it is centralised in the nozzle between the arcing electrode on the high-pressure side of the nozzle and the arcing plate on the low-pressure side, where it is extinguished.

At the same time air is supplied to the motor operating the Isomaker from the blast pipe of the centre unit and, after an interval sufficient to ensure that the arc has been extinguished, it begins to open, the air pressure being maintained until the circuit has been isolated. The closure of the circuit by the Isomaker arm is effected by a three-stage electro-pneumatic valve, the closing coil being de-energised at the end of the closing stroke by auxiliary switches which are operated by the interphase shaft. Single-phase isolators, which are coupled together by a system of links and levers and are manually operated from ground level, are provided for busbar selection, line isolation and by-passing.

CURRENT TRANSFORMERS

Low oil content post-type current transformers are installed near the circuit-breakers. They consist of a V-shaped primary which carries the main insulation of cable paper interposed with conducting layers for voltage grading. Each transformer is filled with Grade N condenser oil under vacuum and is fitted with a nitrogen-oil-seal chamber which permits it to breathe without the insulating oil coming in contact with the atmosphere.

The compressor plant consists of two three-stage air-cooled compressors, manufactured by Belliss and Morcom, Limited, Birmingham, which supply air to main receivers where it is stored at a pressure of 600 lb. per square inch.

The 132 kV system is being linked with a 275 kV switching station on an adjacent site which, it is hoped, will be brought into service in 1956. When finally completed it will contain 20 7,000 MVA air-blast switches and both stations will be operated from the same control room. This room will also contain equipment for controlling the main circuits of the auxiliary supply system in the station and for remotely switching the river water pumps.

CONTROL ROOM

The present desk in the control room is divided into three sections, the two on the wings carrying instruments and controls for the alternators and that in the centre the loading instruction panel and the communication equipment. The mimic-diagram control panel for the 132 kV switchgear extends in an arc in front of the control desk and there is a similar panel for the works auxiliary switchgear at the other end of the room. Provision has been made for the accommodation of panels and desks for controlling the equipment in the future B station.

Power for operating the station auxiliaries is obtained from 6 MVA, 11·8/3·45 kV unit transformers, one of which is connected direct to the terminals of each alternator and from two 10 MVA, 132/3·45 kV station transformers, the latter being manufactured by the British Electric Transformer Company, Limited, Hayes, Middlesex. Medium voltage supplies for the smaller auxiliaries, lighting and other services are obtained from two 750 kVA, 3·3 kV/433 volt and four 500 kVA, 3·3 kV/433 volt transformers. All these transformers are of the outdoor type.

The auxiliary switchgear, which was also manufactured by A. Reyrolle and Company, Limited, is of the single busbar truck type and is air-insulated and solenoid-operated. It is rated at 150 MVA at 3·3 kV and at 25 MVA at 415 volts and is installed in six auxiliary switchhouses. All motors with outputs exceeding 120 h.p. are switched at 3·3 kV, while the smaller machines are supplied at 415 volts and are controlled by air-insulated contactor gear manufactured by Laurence, Scott and Electromotors, Limited. The essential stand-by motors for the turbine oil and hydrogen cooling system are supplied from the main station batteries.

CONCLUSION

The station, which is built on the south bank of the River Trent about three miles from Burton was originally planned by Mr. F. W. Lawton, chief electrical engineer of the Birmingham Electricity Department, and construction was begun under him when he was appointed controller of the Midlands Division of the then British Electricity Authority. It was continued under Mr. L. F. Jeffrey, the present controller of the East Midlands Division, with whom Mr. F. Favell and Mr. R. R. Maddock have been associated as chief generation engineers (construction). The station superintendent is Mr. H. Greenwood. The consulting engineers for the civil engineering work are L. G. Mouchel and Partners, Limited, and the main contractors Sir Robert McAlpine and Sons (Midlands), Limited. The first set was placed in operation in 1954 and all four sets should be completed by the end of the present year.

It may be added that work has already begun on the Drakelow B station. This will contain four 120 MW sets, each of which will be supplied from an 860,000 lb. boiler with steam at 1,500 lb. per square inch and 1,000 deg. F. A re-heat cycle will be employed, the steam leaving the high-pressure cylinder of the turbine at 415 lb. per square inch and 700 deg. F., and being re-heated and returned to the intermediate-pressure turbine inlet at 375 lb. per square inch and 1,000 deg. F. The station will be connected to the 275 kV grid.

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SOCIETY OF CHEMICAL INDUSTRY

75th Anniversary Meeting

"Achievements of Industrial Chemistry" has been selected as the theme for the 75th annual meeting of the Society of Chemical Industry, which will be held in London next year. The nature of the lectures to be delivered will be such as to enable the speakers to review important advances brought about by the work of industrial chemists during the past quarter of a century, and to envisage possible developments during the coming 25 years to the centenary of the Society in 1981.

Following on a general introductory address, there will be two simultaneous series of four lectures. One series will deal with the products of industrial chemistry, the new processes which have been evolved, and the advances in fundamental scientific knowledge which have made them possible. The other series will survey the tools of modern industrial chemistry, covering such subjects as manufacturing techniques, and the use of metals and non-metallic substances in the construction of chemical plants.

Further particulars and a preliminary programme of the meeting are expected to be issued shortly. The headquarters of the Society are at 56 Victoria-street, London, S.W.1.

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ELECTRICITY SUPPLY IN SEPTEMBER

During September, 1955, 5,023 million kWh were sold by the Central Electricity Authority to the English and Welsh Area Boards. This was an increase of 6·5 per cent. over the figure for September, 1954. Allowing for weather conditions and working days, the increase was 9·6 per cent.

The amount of electricity sent out by the Area Boards during the same month was also 5,023 million kWh, of which 149 million kWh were supplied directly by the Central Authority. The increases in the amount sent out, compared with the corresponding figures in September, 1954, were 6·1 per cent., in the "mainly industrial" and 5·1 per cent. in the "mainly non-industrial" areas.

EXTENSIONS TO GASWORKS

Three New Plants at Bromley-by-Bow

Three new plants, comprising a retort house, a boiler house and a gas-pumping installation, at the Bromley-by-Bow Gasworks of the North Thames Gas Board were opened by The Hon. L. W. Joynson-Hicks, M.P., Parliamentary Secretary to the Ministry of Fuel and Power on October 24. The total cost of the plant is £2¼ million.

120 VERTICAL RETORTS

The new retort house, designated No. 5, contains 120 continuous vertical retorts arranged in three benches, all consisting of five settings of eight retorts each. The retorts and the retort house have been built by West's Gas Improvement Company, Limited. The daily coal throughput per retort is 4 tons and the capacity of the plant is 7½ million cub.ft. of gas a day. The retorts are built of Derbyshire siliceous fireclay material; they are 25 ft. long and are heated by producer gas made from coke. Each bench of retorts is equipped with a Spencer-Borecourt horizontal waste-heat boiler generating steam at 300 lb. per square inch, and complete with super-heaters and steam-driven fans. Incoming coal is delivered direct to bunkers in the new retort-house by conveyer belt from a coal-handling plant situated near the gasworks dock. On the outgoing side each bench of retorts has its coke-extraction car discharging on to a 36 in. troughed coke band conveyor. The coke passes finally through a screening plant and the various grades are de-breezed while being loaded on to railway wagons or into sacks.

The raw gas from the retorts is pumped through the by-product recovery plant by one of two steam-turbine driven single-stage turbo-exhausters. Both exhausters have a capacity of 7½ million cub. ft. of gas a day and, while one is operating, the other acts as a stand-by. The gas is then passed through electrostatic detarrers, naphthalene and benzole-recovery plants, ammonia washers and finally through tower iron-oxide purifiers for the removal of hydrogen sulphide.

THREE DOUBLE-DRUM BOILERS

The new boiler plant, supplied by Babcock and Wilcox, Limited, consists of three double-drum W.I.F. (wrought-iron front) type water-tube boilers each having a normal evaporative capacity of 15,000 lb. per hour at a pressure of 300 lb. per square inch, and a temperature of 650 deg. F. They are arranged to burn coke breeze on travelling grate stokers. The furnaces are water cooled, each wall having self-contained circulators, being connected to the drum by separate downcomers and risers. Each boiler has an economiser of the Premier Diamond type, manufactured by E. Green and Son, Limited. A fan which re-circulates the furnace gas puts the front end of the stoker under a slight suction to protect the green fuel from cold draughts and facilitate ignition. The coke breeze is delivered to the plant by motor lorry and elevated by a skip hoist to an overhead hopper. The ash is removed by a conveyer belt and skip hoist to another overhead hopper, and thence by road.

GAS PUMPING PLANT

A new booster house contains two 390 b.h.p. steam-turbine driven gas pumps running at 6,500 r.p.m., supplied by the British Thomson-Houston Company, Limited. Each pump has a capacity of 1 million cub. ft. of gas per hour and they feed gas made at Bromley into the western main from Beckton to the Board's grid system against a maximum outlet gas pressure of 120 in. water gauge. The new building will also house two existing Allen-Bryan Donkin steam-driven pumps, each of 1½ million cub. ft. per hour capacity at a maximum outlet gas pressure of 100 in. water gauge. These will pump gas into a medium-pressure main supplying the northern and Hornsey districts.

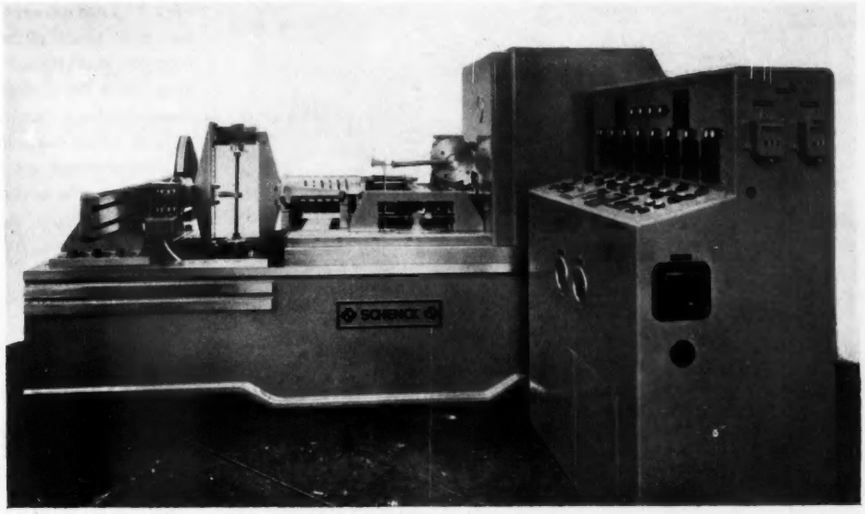

Fig. 1 The Schenck fatigue-testing machine will carry out automatically a pre-set programme of tests, the load and number of cycles in each step being variable over a large range.

FATIGUE TESTING TO A PRE-DETERMINED PROGRAMME

SIMULATING COMPONENT WORKING CONDITIONS

Sufficient data have been accumulated in recent years, particularly in the aircraft field, to enable the pattern of stresses imposed on a component during its working life to be determined with considerable accuracy. The use of strain-gauges on aircraft in flight, for example, has made it possible to record the actual working stresses over a period, and thus to formulate a programme for the laboratory testing of components. This technique can be, and is used with equal success in other fields.

In order to simulate the working conditions of a variety of components, Carl Schenck Maschinenfabrik, G.m.b.H., Darmstadt, Germany, have introduced a modified form of their Pulsator fatigue-testing machine, which will reproduce the varying stresses and operate automatically to a pre-determined programme. The machine is marketed in the British Commonwealth by W. & T. Avery, Limited, Soho Foundry, Birmingham, 40. Provision is made in the design of the machine for carrying out tension, compression, bending, torsion, and combined-load tests on a variety of components.

Fig. 1 shows the machine set up for testing a torsion bar under alternating torsion-load conditions; other attachments available include devices for bending tests, for alternating shear tests and for many other types of test according to the conditions of service of the component. The machine has a long maximum working stroke, which makes it suitable for testing flexible components.

VARYING PULSATING AND STATIC LOADS

The basic design of the machine is similar to other Pulsator machines in the Schenck range, but both high-frequency and low-frequency loads can be applied; these can be varied as required, and they can be combined with a static pre-load or not according to requirements. In addition there is an automatic programme-control mechanism which enables any pre-determined loading pattern to be set and maintained without manual attention.

The machine has a heavy box-section base, filled with barytes or other dense material, and

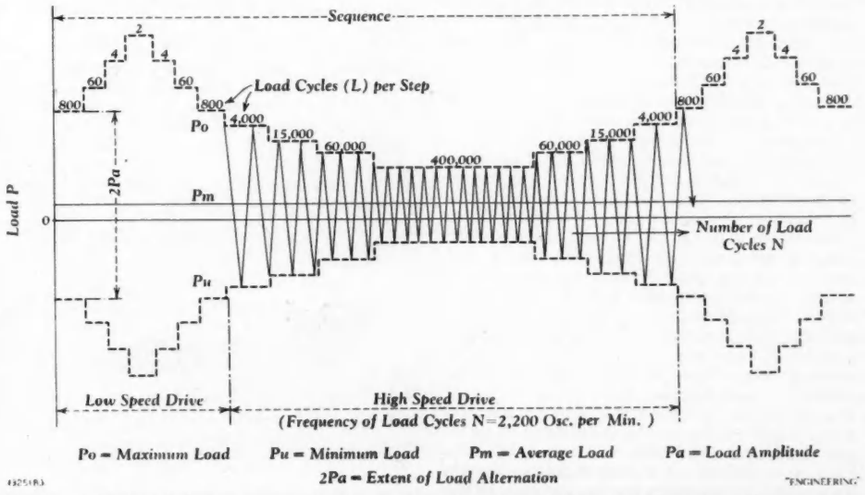

Fig. 2 A typical test programme is shown here diagrammatically. The machine changes automatically from one step to the next after the required number of stress-reversals has been applied.

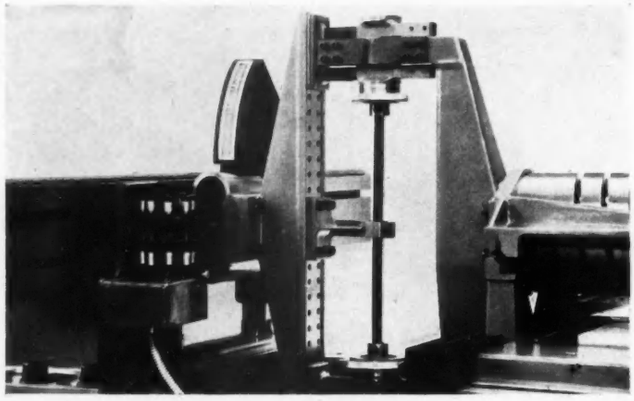

Fig. 3 Load maintenance is by means of the contacts seen immediately below the vertical load-indicating scale. A fresh set of contacts is indexed round automatically at the beginning of each step in the programme.

mounted on rubber feet to prevent transmission of vibrations to the floor. At one end of the base is an anchorage for a loop-dynamometer, which measures the load. The test-piece is attached to this dynamometer and the load is applied by mechanisms at the opposite end of the machine. The space between the load-applying and load-measuring units is adjustable to accommodate test-pieces of varying length and type, together with the necessary adaptors or fixtures.

High-frequency loads are applied by an electric motor and adjustable-throw eccentric, coupled to an exciter spring, which sets up oscillations in the test-piece carrier. By changing the speed of the motor and therefore of the exciter, the load can be varied during operation; the extent of the load is determined by measuring the deflection of the loop-dynamometer. Low-frequency loads are applied by a double-acting hydraulic cylinder mounted in line with the high-frequency mechanism. In addition to these two types of load, a static pre-load can also be applied. This is obtained by pre-loading the large helical spring in the machine base.

Load measurements are taken by the loop-dynamometer on which the test-piece is mounted. A mirror on the dynamometer, and a light source project a band of light on to a ground glass screen, the position on the screen of the band of light indicating the extent of the static load, while the width of the band shows the pulsating load.

PROGRAMME CONTROL

According to the data required, it may be necessary to apply both low-frequency and high-frequency loads, and to vary them considerably in extent and number of cycles. A typical programme is shown in Fig. 2.

To control the machine in the required pattern of loading, it is equipped with a number of electric counters working in conjunction with the motor and the hydraulic pump. These are hand-set to the number of cycles required in each step in the programme, and are brought into operation automatically in sequence. The extent of the high-frequency load, which is adjusted by varying the speed of the motor, is controlled by a set of contacts which are mounted in front of the machine and operated by a finger on the loop-dynamometer. These contacts are adjustable by means of thimbles similar to those used on micrometers, and are set by hand to the correct distance apart for the load required in each step in the programme. The contacts are visible in Fig. 3, which also shows the load-indicating screen. On the machine illustrated there are eight counters and eight pairs of contacts, giving a series of eight steps which can be controlled automatically. This number can be varied according to circumstances.

To carry out a programme of tests the counters and contacts are first set to the number of cycles and load-values required in each step. The machine is then started, and the contacts maintain the load at the set figure for the duration of the first step in the programme. At the conclusion of this step the first counter has returned to zero, and it operates an electric contact. This causes the load-maintaining mechanism to be indexed to the next station, and a fresh pair of contacts is brought into line with the finger on the dynamometer. The new load conditions are thus set, and they are maintained until the second counter reaches zero, when the required conditions for the third step are set automatically in the same way. At the end of the eighth step the first step is re-set automatically, and the cycle is repeated; this continues until the test is completed, and the machine is stopped.

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SCIENTIFIC APPROACH TO FURNITURE DESIGN

Research and Cost Accounting

New premises for the research department and technical information service of the Furniture Development Council were officially opened, at 2–4 Dalmeny-avenue, London, N.7, on Tuesday, October 25. The Furniture Development Council is a statutory organisation, financed partly by a compulsory levy on the furniture industry and partly by a grant from the Department of Scientific and Industrial Research; it comprises representatives from the employers, the British Furniture Manufacturers Federated Association (B.F.M.), the trade unions, and independent members. On the Council's research and information committee, D.S.I.R. is represented and the manufacturers have additional representation.

Shortly before the opening of the new headquarters, the B.F.M. put forward a suggestion that the Development Council should be wound up. In a speech at the luncheon which preceded the opening ceremony, the chairman of the B.F.M., Mr. Charles Lakin, M.B.E., referred to this proposal and made it clear that the manufacturers appreciate the value of research and are well satisfied with the existing research and technical information staff, but that they wish to see the work carried out under the control of an independent research association.

The present activities of the Council are not confined to research and technical informaion services. Since cost accounting methods in the furniture industries are, generally speaking, somewhat rudimentary, probably some of the Council's most valuable work is concerned with the costing services, of which they provide two: a comparative costs scheme which enables manufacturers—without disclosing their identities—to compare annual break-downs of operating costs; and an individual costing service to enable firms to appreciate the build-up of cost for each of their products. Another useful service is provided by the method study section, which offers training and appreciation courses in method study as applied to the furniture industries, and a consulting service.

Research activities are directed primarily towards economy in materials. Current investigations include repeated load tests on joints, and tests on the relative bending strength of mortice-and-tenon and dowel joints; performance tests on furniture to check the strength of new constructions, methods, and materials; theoretical and experimental work on cabinet construction under various loading conditions, to determine the most suitable structural forms; and the darkening of veneers. Tests on finishing materials have recently begun, and preliminary investigations are under way to determine a method for assessing the pressure distribution in upholstered and non-upholstered seats. Work recently carried out on synthetic resin adhesives includes the invention of an aluminium-foil strip resistance heater embedded in the glue line to accelerate the setting of the adhesive. The strip, which has no effect on cutting tools, remains embedded in the joint.

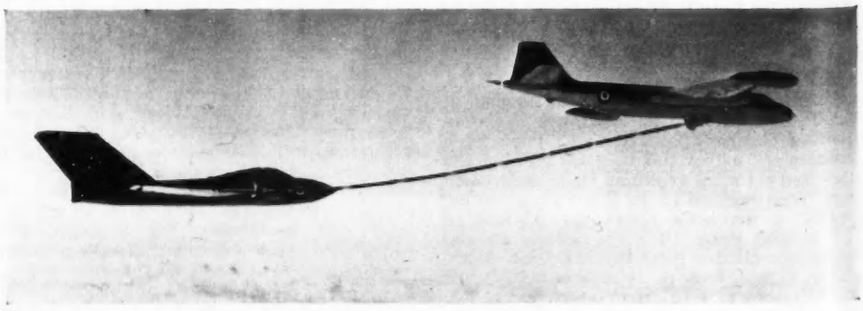
REFUELLING THE JAVELIN IN FLIGHT

The accompanying illustration shows the Gloster Javelin all-weather fighter equipped with a probe for refuelling in flight at high speed. It was taken during recent trials when the Javelin was refuelled from an English Electric Canberra B.1 bomber equipped as an experimental tanker.

Both aircraft were fitted with the probe and drogue equipment designed and produced by Flight Refuelling, Limited, Blandford, Dorset. This system, it may be recalled, was used with great success by United States Air Force fighters during the war in Korea, and it is the standard equipment used in fighters of the United States Navy. It is to be adopted for use in the V-class bombers of the Royal Air Force.

The trials carried out with the Javelin are the first to be undertaken with any British post-war fighter aircraft. Being able to take on fuel whilst airborne would give the Javelin almost unlimited range.

For the purpose of the trials, the probe was located along the leading edge of the Javelin's starboard mainplane, but it can, of course, be located in an aircraft's nose, in tip tanks or in drop tanks if required.



Refuelling the Gloster Javelin in flight by the probe-and-drogue method. Fuel is transferred from an English Electric Canberra equipped as a tanker.

SWITCHGEAR RESEARCH LABORATORY

SHORT-CIRCUIT TESTING FACILITIES IN SCOTLAND

As a company expands the speed of its technical progress depends on how quickly it can obtain the results of research and how quickly those results are applied to production. There comes a time when the lack of adequate research facilities causes great inconvenience in the development and testing of new materials and equipment, and at that stage the only solution is to design and build a research laboratory specifically for the company's use. This stage has been reached by the Belmos Company, Limited, Bellshill, Lanarkshire, and on October 25, their new research laboratory was opened by Dr. S. Whitehead, M.A., M.I.E.E., director of the Electrical Research Association.

The company was founded in 1919, and in 1926 concentrated on the manufacture of flameproof electrical gear for use in mines, serving the pits of the Lanarkshire coalfield. More recently the company has entered the field of industrial switchgear and control gear, and the expansion needed another factory. This was found at Blantyre, some four miles from the original factory at Bellshill, and the new research laboratory has been built at the Blantyre factory.

The laboratory consists of a plant for short-circuit testing switchgear and contactors, and other facilities for experiments on materials, circuits, etc. The testing of switchgear and control gear has previously been done outside Scotland, either at the A.S.T.A. testing stations in England, or the stations in Holland or France. Transferring equipment and staff and hiring the testing facilities for the duration of the tests were naturally expensive and wasteful in time; in addition, the station designed for testing circuit-breakers up to the largest ratings used on transmission systems cannot always provide economical or satisfactory conditions for work on contactors and on circuit-breakers of smaller capacity. The Belmos circuit-breakers are all air-break, and therefore there was no necessity for the elaborate safety precautions which apply to the testing of oil circuit-breakers.

The source of power for the short circuit tests is a 625 kVA alternator running at 750 r.p.m. The alternator is driven through multi-belt transmission and reduction gearing by an 80 h.p. induction motor. The output circuit of the alternator is taken through a master breaker to reactors and resistors for controlling the current magnitude and power factor, a make switch for initiating the short circuit, auto-transformers to give the required voltage ranges, and finally to a test cell in which is mounted the apparatus under test.

The alternator windings can be connected in star or delta, and an output of 440 volts can be obtained with either connection. Commissioning tests have shown that short-circuit currents up to 12,000 amperes, corresponding to 9·2 MVA, can be produced, and the end windings have been specially reinforced, as shown in Fig. 1, to withstand the consequent electromagnetic forces. The alternator field is supplied from a separate exciter set. For emergency shut down of the set there is a battery operated dynamic braking system which can bring the alternator to rest in 1½ minutes. The master breaker is installed to disconnect the alternator from any sustained short-circuit on the apparatus being tested, and is rated at 25 MVA at 440 volts.

In some cases a breaker under test is initially closed on to a short-circuit, and is required to clear the fault when the circuit is connected to the alternator. To make this connection a switch to limit arc burning is used; it is a three-phase isolator fitted with a spring closing system, the springs being charged by a compressed air thrustor between tests. The closing mechanism is designed so that the switch can be synchronised to close at any pre-selected point on the voltage waveform.

The auto-transformer is used for testing at voltages other than the generated 440 volts, and the range is up to 700 volts with a corresponding lessening of the current available. The test cells, shown in Fig. 2, are enclosed by brick walls on three sides; the fourth is left open for observation, but can be closed by a metal grid as an additional safety measure.

The control and measuring equipment is at a safe distance from the test cells, as Fig. 2 shows. When the alternator has been run up to speed on open circuit, control is transferred to the desk to the left of the operator, and from there all subsequent operations can be performed. In any one test a number of operations have to be carried out in a pre-determined time sequence, which is provided by a multiple-cam controller with 20 channels. Measuring equipment is provided to obtain all possible information from each test. The 12 element electromagnetic oscillograph at the right foreground of Fig. 2 records the transient test conditions. It has vibrators for various frequency ranges and watt measurement, each having built-in calibration controls and coarse and fine logarithmic shunts for final control of the deflection amplitude. Signals from the twelve elements are recorded photographically on either drum or continuous-feed cameras. Connections between the main plant, test cell, cam controller and oscillograph are made easier by a plug board, shown in Fig. 2.

In the remainder of the laboratory there is equipment for carrying out experiments on components and circuits. There are also offices for the research staff, a conference room, and a dark room. Research is being conducted at present on a number of items, among which are industrial and flameproof earth-leakage relays, magnetic materials, and intrinsically-safe circuits for mining applications.

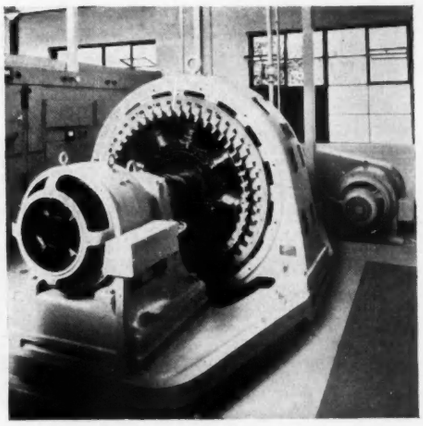


Fig. 1 The end windings of the 625 kVA alternator have been specially strengthened to withstand electromagnetic forces produced by heavy short circuit currents. The alternator is run up to speed by the 80 h.p. induction motor seen in the right background.

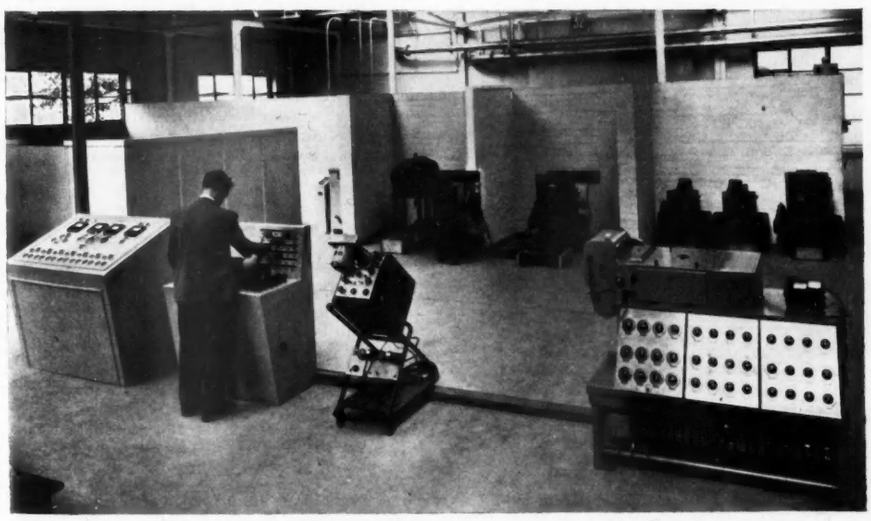


Fig. 2 A general view of the short-circuit testing plant. In the foreground are the control desk, plug panel and measuring equipment. The back walls of the test cells conceal the alternator, reactors, resistors and main switches.

* * *

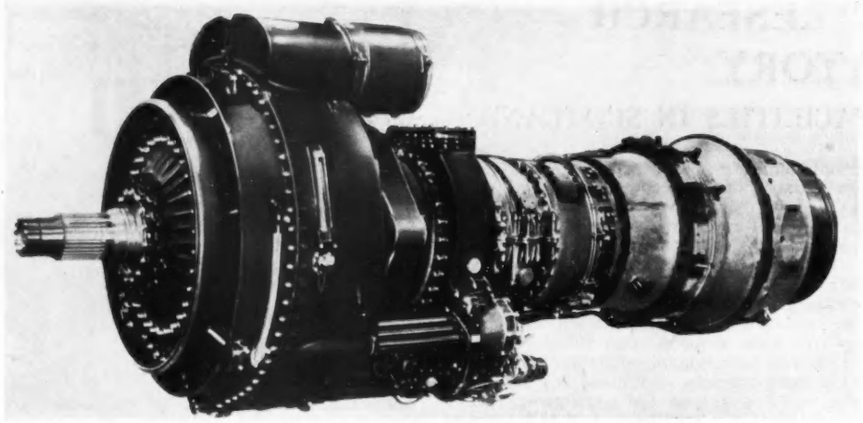
HIGH-SPEED PHOTOGRAPHY

London Congress in 1956

High-speed photography and cinematography are rightly regarded as exceedingly important research tools in connection with a wide range of technical and scientific problems, many of which can most readily be solved by means of these comparatively new techniques. Much progress has been made in this regard during the past ten years and recent developments will be discussed at the Third International Congress on High-Speed Photography, which is due to be held at Government Offices, Horse Guards-avenue, London, S.W.1, from Monday, September 10, to Saturday, September 15, 1956. The congress will take place under the auspices of the Department of Scientific and Industrial Research.

Papers to be presented will deal with optical and drum cameras; flash sources for high-speed photography and cinematography; high-speed shutters; scanning and image-dissection methods; and the application of recent research techniques to industrial machine analysis, atomic energy and explosion studies, and to hydrodynamic, aerodynamic, medical and biological problems. An exhibition of associated equipment will be held concurrently with the congress.

Persons or firms desiring to contribute papers or to supply exhibits should communicate with the congress secretariat, Department of Scientific and Industrial Research, Charles House, 5-11 Regent-street, London, S.W.1.



The Rolls-Royce R.B.109 Tyne propeller turbine is a two-spool engine with a two-stage 12-to-1 axial-flow compressor developing 4,470 e.h.p. for take-off. Specific weight is 0·42 lb. per e.h.p., specific fuel consumption (cruising) 0·414 lb. per e.h.p. per hour.

THE TYNE PROPELLER TURBINE

HIGH POWER/WEIGHT RATIO, LOW FUEL CONSUMPTION

Some general particulars of the Tyne propeller turbine which, as announced recently, is to power British European Airways' future fleet of Vickers Vanguard air liners, have been given by its manufacturers, Rolls-Royce Limited, Derby. The engine is shown above.

At sea level static conditions, the Tyne, originally known as the R.B.109, develops 4,020 s.h.p. plus 1,175 lb. thrust, giving a total equivalent power of 4,470 e.h.p. Cruising at 425 m.p.h. at 25,000 ft., the engine produces a total equivalent power of 2,470 e.h.p.; the fuel consumption is 0·414 lb. per e.h.p. per hour. The net dry weight is 1,880 lb. and the specific weight 0·42 lb. per e.h.p. The length, to the exhaust cone fitting line is 97·15 in., and the engine is 40·5 in. high and 37·4 in. wide. The propeller reduction gear ratio is 0·062 to 1.

Thus, although the specific weight of the Tyne is 37 per cent. less than that of the Dart, at representative cruise conditions the Tyne will start its service life giving 2·8 times the cruising power of the Dart when it first went into service, with a 40 per cent. less specific fuel consumption.

The good economy of the Tyne results from the use of a high pressure ratio of 12 to 1, possible by adopting a two-shaft axial-flow compressor, and by operating at higher flame temperature. Design improvements derived from the latest military turbojets have been incorporated in the Tyne, which allow the use of these higher temperatures without impairing the overhaul life of the engine.

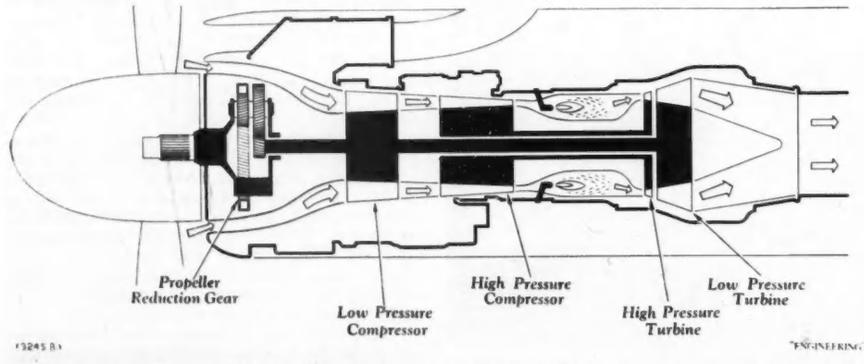
The high-pressure compressor is driven by its own turbine, and the low-pressure compressor and the propeller are driven by a separate turbine, the shaft of which runs inside the high-pressure shaft. This arrangement can be seen in the illustration below. The propeller is coupled to the low-pressure shaft through a compound epicyclic reduction gear, the internal mounting of which has been specifically designed to damp out vibration and thus improve engine reliability and also passenger comfort; these aspects have also been taken into consideration in the design of the engine mounting. In addition, considerable flight testing has been done to determine the relative importance of the various factors which affect noise.

The engine is controlled by a single throttle lever interconnected with the propeller controller. This, together with an automatic temperature control, maintains the correct relationship between power and propeller speed for take-off from aerodromes at different altitudes and temperatures and also ensures maximum economy with changing air temperature and speed.

It is essential for a propeller turbine engine in a transport aircraft to maintain high propeller speed with minimum power under approach conditions to ensure maximum thrust response in the event of the necessity for an emergency acceleration. Provision has been made in the design of the Tyne to meet this requirement. Provision has also been made for reverse pitch on the propellers to provide the braking which is now a standard feature of transport aircraft.

The de-icing system on the Dart engine has proved very satisfactory and the de-icing of the propeller, spinner and the air intake leading edge of the Tyne is based on experience gained using the Dart system. Provision has also been made for anti-icing of the blades of the compressor based on comprehensive icing tests on axial-flow jet engines.

Extensive work on the bench and in flight has been carried out on the Dart engine to investigate the consequences of a failure in the engine or in the control system, and to prove that the engine is safe under these conditions. The results of this work, including investigation into failures and measures to prevent recurrence, have been incorporated in the Tyne.



The high-pressure compressor is driven by its own turbine, and the low-pressure compressor and the propeller are driven by a separate low-pressure turbine, the shaft of which passes through the hollow high-pressure shaft. The propeller is coupled to the low-pressure shaft through a compound epicyclic train.

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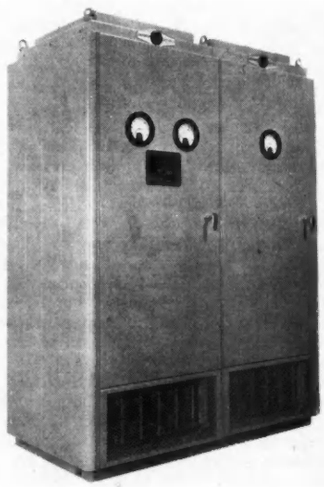
POWER GERMANIUM RECTIFIER OF 1,000 kW

Continuous Full Load Operation

The illustration below shows the first power germanium rectifier to be put into normal commercial service in this country. It was manufactured by the British Thomson-Houston Company, Limited, Rugby, to the order of Imperial Chemical Industries, Limited, and is rated at 1,000 kW, 255 volts and 3,920 amperes. It will operate at full load for long periods.

As will be seen, the rectifier consists of two cubicles. They house a series-parallel arrangement of air-cooled germanium rectifier cells, which are connected to form a six-phase full-wave bridge. It is supplied from an existing delta/diametric-connected transformer, which previously was connected to a rotary converter.



Germanium rectifier of 1,000 kW for commercial service, with series-parallel arrangement of air-cooled cells.

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ELECTRICITY AND TRANSPORT

B.E.P.C. 1956 Convention

Some 2,000 delegates are expected to attend the Eighth British Electrical Power Convention, which will be held at Torquay from Wednesday, May 23, to Tuesday, May 29, 1956, under the presidency of Sir John Dalton, chairman of W. T. Henley's Telegraph Works Company.

The theme of the Convention will be "Electricity and Transport" and the subjects likely to be discussed will include the forthcoming modernisation of British Railways, electric-battery vehicles, trolley-buses, signalling and the uses of electricity in the shipping and aeronautical industries. There will also be a lecture and demonstration on "The All-Electric House." The offices of the Convention are at Winsley-street-Oxford-street, London, W.1.

PASSENGER LINER WITH ENGINES AFT

BEHAVIOUR OF S.S. SOUTHERN CROSS

The S.S. Southern Cross was designed to carry only passengers and crew, and has its propelling machinery mounted aft rather than amidships in the conventional way. The consequences of deciding to design a liner with no provision for cargo follow in logical sequence, and were discussed in an article in ENGINEERING for March 18, 1955 (vol. 179, page 350). Installing the machinery aft allows the public rooms to occupy the best part of the ship amidships; problems of trim are overcome by providing appropriate water-distilling plant, and air-conditioning of the centre-line cabins and public rooms is achieved by plant of suitable capacity.

In a paper entitled "Passenger Liner with Engines Aft," read before the Institute of Marine Engineers on October 11, Mr. R. K. Craig, Chief Superintendent Engineer, Shaw, Savill and Albion Company, Limited, discussed the reasons that had led to the unusual design of the Southern Cross. He described some of the engineering problems arising from the design and concluded by giving some results of the maiden voyage. A general account of the reasons for the design and the machinery installed were given in the article mentioned above, but Mr. Craig's paper raised several interesting points.

Modifications were demanded by the Ministry of Transport and Civil Aviation to ensure damage stability, as a result of which the vessel could arrive in port with 3,500 tons of ballast water on board. Because the ship worked to a tight schedule, and time in port was limited, it was found necessary to revise the arrangements for ballasting and dealing with only ballast water. Existing plant was scrapped, and the new plant fitted could deal with 500 tons per hour of oil ballast water. It comprised two 250 tons per hour separators with automatically controlled oil and water discharges and two 250 tons per hour centrifugal ballast pumps.

Moving the machinery aft meant that the numerous pipe services for ballast, boiler and Diesel fuel filling, bilge, steam heating, etc., had to pass from the source in the engine room through the intervening machinery spaces to the forward end of the vessel. It was impossible to avoid congestion in some places, and a leak in the lower pipes would be a major job to repair.

FUNNEL DESIGN

Another feature that presented difficulty was the behaviour of funnel gases in a following wind. Wind-tunnel experiments were carried out by the Aerodynamics Division of the National Physical Laboratory on a model of the Southern Cross to evolve a satisfactory funnel design. In the first design the three uptakes from the boilers were widely separated within the casing, but in the following designs all the uptakes were concentrated together at the outlets, and it was arranged that the efflux velocity of the plume should not fall below 80 ft. per second, independent of the ship's speed. In the actual ship's funnel this velocity is maintained by dampers fitted in each uptake at the funnel top. The results with the model showed that with winds all round the compass the ship was free of smoke pollution.

After the experiments were concluded it was decided to fit a fan within the funnel casing and connect it to an annulus 4 in. wide, which completely bounds the uptakes from the three main boilers and the two auxiliary boilers. It is hoped to bind the gases within this hollow jet of high velocity air and thus allow them to rise further before succumbing to the horizontal flow of the natural wind and the resulting low pressure pockets caused by the ship's structure. The fan was fitted primarily to help carry the funnel gases clear, but it will probably also have a secondary benefit in improving the ventilation of the boiler room and the pipe tunnel from the generator room.

The behaviour of the Southern Cross on her maiden voyage was excellent, and absence of noise and vibration was marked. The main distilling plant worked well and it was possible to satisfy all fresh-water demands throughout the trip.

There was, however, some trouble concerning the control of scale and the injection system for the ferric chloride. When the vessel sailed into the hotter sea temperatures, it was found that to maintain the output, the shell pressure in the first evaporator rose to 6 lb. per square inch, consequently raising the temperature into the range suitable for scale deposition. At Sydney 6 cwt. of scale was removed from No. 1 evaporator and the coils were quite well covered with scale that had not cracked away. The quantity of ferric chloride was increased from 66 lb. to 90 lb. per day and this helped to stabilise matters but did not remove the scale on the coils. The trouble experienced with the injection system was the failure of the polythene piping, and by the voyage end the engineers had had plenty of practice in welding this material. Investigation of the burst pipes showed them to be choked with a scale that had formed after mixing the ferric chloride solution. It was found that this scale occurred due to the mixing of the chemical with sea water; fresh water had subsequently been laid on, and the diameter and thickness of the injection piping had been increased. The feed system had also been altered to allow series feeding, and all the water now went through the first evaporator, thus allowing a low density to be carried at the highest temperature point without undue thermal loss. The system was reported to be working very well, with the coils in all three evaporators completely free of scale.

The air-conditioning plant worked very well indeed; the main call was found to be the setting of the separate controls for the units. This was eased, however, as they became more familiar. Even in the tropics two blankets were always needed as a cover at night.

The main engines, boilers, and Diesel generators, all ran well and without trouble. Performance figures in lb. per s.h.p. are given in the accompanying table. Item (1) includes oil fuel main engines and auxiliary boiler; item (2) the Diesel oil generating plant; item (3) is the total power developed by main and auxiliary engines divided by the total fuel.

TABLE :—*Consumption, lb. of fuel per s.h.p.*

	(1) Main Engines	(2) Auxiliary Engines	(3) Main and Auxiliary Engines
Outward Southampton-Wellington (average speed 18·5 knots)	0·652	0·408	0·617
Southampton-Trinidad (average speed 18·37 knots)	0·603	0·486	0·590
Homeward Wellington-Southampton (average speed 18·52 knots)	0·647	0·418	0·619
Freemantle-Durban (average speed 18·55 knots)	0·627	0·431	0·605

LAUNCHES AND TRIAL TRIPS

M.S. "THOR ODLAND."—Single-screw cargo vessel, with accommodation for twelve passengers, built and engined by Burmeister and Wain Ltd., Copenhagen, Denmark, for D/S A/S Produce (associated with Jacob Odland S.S.), Haugesund, Norway. Main dimensions: 400 ft. between perpendiculars by 55 ft. 6 in. by 35 ft. 6 in. to upper deck; deadweight capacity, 7,500 tons on a draught of about 24 ft. 6 in.; cargo-carrying capacity, about 470,000 cub. ft. Six-cylinder single-acting two-stroke crosshead Diesel engine, developing 7,100 i.h.p. at 125 r.p.m., and arranged for burning heavy oil. Speed on trial 17 knots, fully loaded. Trial trip, October 7.

M.S. "CITY OF COLOMBO."—Single-screw cargo vessel, built and engined by Barclay, Curle & Co., Ltd., Whiteinch, Glasgow, for the eastern trade of Ellerman Lines Ltd., London, E.C.3. Main dimensions: 470 ft. by 65 ft. 6 in. by 32 ft. 6 in. Barclay Curle-Doxford six-cylinder opposed-piston oil engine, arranged for burning heavy oil. Launch, October 7.

M.S. "BORDER REIVER."—Single-screw oil tanker, built by Sir James Laing and Sons, Ltd., Sunderland, for the Lowland Tanker Co., Ltd. (Managers: Common Brothers, Ltd.), Newcastle-upon-Tyne. Seventh vessel of a series of ten for these owners. Main dimensions: 515 ft. between perpendiculars by 69 ft. 6 in. by 37 ft. 6 in.; deadweight capacity, 16,182 tons on a summer draught of 30 ft. 0½ in. Six-cylinder opposed-piston oil engine constructed by William Doxford and Sons, Ltd., Sunderland. Engine arranged for burning heavy-oil fuel. Service speed, 14 knots. Trial trip, October 9 and 10.

M.S. "FERNBANK."—Single-screw cargo vessel, with accommodation for twelve passengers, built and engined by Eriksbergs Mek. Verkstads Aktiebolag, Gothenburg, Sweden, for A/S Glittre, a subsidary company of Fearnley and Eger, Oslo, Norway. Main dimensions: 450 ft. between perpendiculars by 64 ft. by 41 ft. to shelter deck; deadweight capacity, about 9,900 tons on a draught of 28 ft. 1 in. Eriksbergs-B. and W. eight-cylinder single-acting two-stroke Diesel engine, developing 10,000 b.h.p. and arranged to operate on heavy oil. Service speed, 17¾ knots. Delivered, October 12.

M.S. "SARGODHA."—Single-screw cargo vessel, built and engined by Burmeister and Wain Ltd., Copenhagen, for the East-Asiatic Co., Ltd., Copenhagen, Denmark. Main dimensions: 456 ft. between perpendiculars by 62 ft. 6 in. by 29 ft. 6 in. to second deck; deadweight capacity, 9,944 tons on a draught of about 26 ft. 4 in. B. and W. seven-cylinder single-acting two-stroke Diesel engine, arranged for burning Diesel oil or boiler fuel and developing 9,800 i.h.p. at 115 r.p.m. in service. Speed about 16·8 knots, fully loaded. Launch, October 12.

M.S. "MICHAEL G. LIVANOS."—Single-screw cargo vessel, built by the Burntisland Shipbuilding Co., Ltd., Burntisland, Fife, for the Fomentador Compania Naviera S.A., Panama. Main dimensions: 435 ft. between perpendiculars by 59 ft. 9½ in. by 39 ft. 6 in. to upper deck; deadweight capacity, about 11,800 tons on a draught of about 29 ft. 3 in. Kincaid-B. and W. seven-cylinder single-acting two-stroke Diesel engine, developing 5,500 b.h.p. at 120 r.p.m. in service, constructed by John G. Kincaid & Co., Ltd., Greenock, and installed by the shipbuilders. Engine arranged for operating on heavy-fuel oil. Launch, October 17.

M.S. "O. B. SÖRENSEN."—Single-screw oil tanker, built by Sir James Laing and Sons, Ltd., Sunderland, for Smith Sörensens Tankrederi A/S, Arendal, Norway. Stated to be the largest oil tanker so far launched on the Wear. Main dimensions: 597 ft. 6 in. between perpendiculars by 79 ft. by 46 ft. 4 in.; deadweight capacity, about 27,000 tons on a draught of 33 ft. 6 in. Six-cylinder opposed-piston oil engine, constructed by William Doxford and Sons, Ltd., Sunderland. Launch, October 17.

M.S. "ROSS LION."—Single-screw trawler, built by Cochrane and Sons, Ltd., Selby, Yorkshire, for Trawlers Grimsby Ltd., Grimsby. Main dimensions: 115 ft. between perpendiculars by 25 ft. by 12 ft.; gross tonnage, about 270. Six-cylinder Diesel engine with oil-operated combined reverse-reduction gearing, developing 605 b.h.p. at 430 r.p.m. in service. Propelling machinery constructed by Ruston and Hornsby Ltd., Lincoln, and installed by Amos and Smith Ltd., Hull. Launch, October 17.

H.M.S. "MALCOLM."—Anti-submarine frigate, built by Yarrow & Co., Ltd., Scotstoun, Glasgow, for the Admiralty, London, S.W.1. Length 310 ft. overall and beam 33 ft. Armament comprises three Bofors guns and two three-barrelled anti-submarine mortars. Propulsion provided by geared steam turbines constructed by the Parsons Marine Steam Turbine Co., Ltd., Wallsend-on-Tyne. Launch, October 18.

M.S. "DEFENDER."—Single-screw cargo vessel, built and engined by William Doxford and Sons, Ltd., Sunderland, for the Charente Steam Ship Co., Ltd. (Managers: Thos. and Jas. Harrison, Ltd.), Liverpool. Main dimensions: 464 ft. 9 in. overall by 59 ft. 5 in. by 37 ft. 8 in.; deadweight capacity, 9,570 tons. Doxford four-cylinder opposed-piston oil engine. Service speed, about 13½ knots. Delivered, October 19.

DOCKSIDE CARGO CRANE WITH HYDRAULIC LUFFING

ELECTRIC AND HYDRAULIC MOTIONS COMBINED TO GIVE SMOOTH SHOCK-PROOF OPERATION

Hydraulically-operated cranes were always noted for their simplicity and quiet smooth operation. A new crane, the Clyde Level Hydral-Luff crane, built by the Clyde Crane and Engineering Company, Mossend, Lanarkshire, has been designed with the object of retrieving some of the advantages that were lost with the extensive use of electric cranes. It is virtually an electric crane but fitted with hydraulic luffing motion, thereby restoring to the electric crane the advantages formerly associated with hydraulic luffing. It is operated by independent motors for each motion and is arranged for level luffing by means of the company's own system of hydraulic luffing.

The L.H.L. crane, shown in Fig. 1, is a high-speed cargo-handling crane designed for dockside working. The maximum working radius is 60 ft. when a load of ¾ ton can be lifted at 380 ft. per minute; the maximum load, handled at the minimum radius of 16 ft., is 3 tons, which can be raised at 200 ft. per minute. Luffing between the extreme positions is accomplished in 18 seconds, the slewing speed is approximately 2 r.p.m., and the travelling speed 50 ft. per minute on rails at 15 ft. centres. From rail level to the jib heel is 49 ft. 0 in. and to the hook, minimum radius, is 93 ft. 0 in. and at maximum radius, 63 ft. 0 in. The lowest reach of the hook at all positions of the jib is 67 ft. below rail level, giving total lifts of 160 ft. and 130 ft. at the minimum and maximum radius respectively.

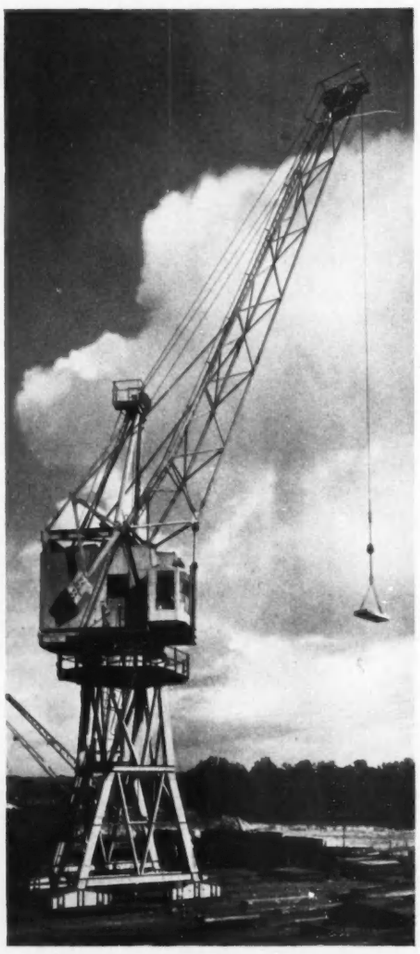

Fig. 1 The Clyde Level " Hydral-Luff " (L.H.L.) crane. It has a maximum reach of 60 ft. and a maximum lift above rails of 90 ft.; the corresponding maximum loads are ¾ and 3 tons respectively. Other than the jib, no part of the superstructure projects outside the tail radius and the luffing system involves little of the shafting associated with mechanical luffing.

In all respects workmanship is in accordance with the relevant British Standards, in particular B.S. 2452 (High Pedestal or Portal Jib Cranes, Type " A ") and B.S. 2573 (Report on Permissible Stresses in Crane Structures), where applicable. The special features of the crane are the speed and ease with which it can be handled, the advantageous position provided for the driver to give him a full view of his work, and the care taken to place the few controls in such a position that they come naturally to the driver's hand.

CARRIAGE AND SUPERSTRUCTURE

The carriage is of the portal type, of steel construction, suitably stiffened and triangulated to secure adequate rigidity. The superstructure consists of a structural steel base which supports a tower carrying the jib foot pin and forming the mast for the luffing ropes. Mounted on the superstructure is a combined driver's cabin and machinery house. It is constructed from ¼ in. thick sheet steel with the necessary windows in metal window frames. Arrangements allow all windows to be cleaned from the carriage platform, or alternatively, by means of opening the windows and from the inside of the cabin.

As there are no mechanical luffing shafts passing through the cabin, there is ample room for the housing of machinery and adequate access to all parts requiring maintenance.

The crane has been designed with particularly easy access in mind. A ladder and handrails with suitable protecting loops and resting stages are fitted to give access to the platform at the top of the carriage. This is a circular platform and from this, by means of a short fixed ladder, it is possible to reach the driver's cabin and the machinery house with the crane slewed in any position.

A hatch is fitted in the roof of the machinery house, together with a ladder and the necessary platforms so that the jib feet and the luffing pulleys can be reached easily for maintenance and lubrication purposes. A further ladder is provided up the jib with handrails and a platform at the jib head to give access for maintenance of the jib-head pulleys. The handrails consist of tubes mounted on tubular and/or angle-iron stanchions, as necessary.

A hand-operated maintenance runway is fitted and can be extended through a hinged panel in the front of the cabin so that a motor or other piece of machinery can be brought out of the cabin and clear of the superstructure for lowering to ground level.

JIB AND ROPES

As may be seen from Fig. 1, the jib is of triangular section and tubular construction; balance weights are carried on supporting levers which are connected by ties to a point approximately midway up the jib, this arrangement assisting in neutralising the bending moment in the jib and thus allowing a lighter construction.

The hoist rope is led from the barrel to a pulley at the top of the mast and thence reeved between the mast and the jib head to secure the level luffing motion. The load is lifted on a single fall of rope. A short piece of chain is fitted between the rope eye and the C-type Liverpool hook which is mounted on a ball-bearing swivel and fitted with an overhauling weight of ample capacity.

HOISTING AND SLEWING

The hoist is driven by means of single-stage high-efficiency worm reduction gear to a steel machine-grooved barrel with large-diameter flanges, a solenoid brake being provided to hold the load. Slow speeds are obtained by the B.T.H. " Stacreep " system which gives two stops of slow-speed control when hoisting or lowering.

The crane is mounted on a circular roller path which is renewable and which revolves on a ring of taper rollers. The segmental slewing rack is independent of the roller path; it has involute teeth of machine-moulded construction and having a pressure angle of 25 deg.

The spur pinion engaging with the slewing rack is carried eccentrically in a housing forming the case for the slewing motor and reduction gear. By revolving this housing the meshing of the slewing pinion can be adjusted and set to the required degree of backlash.

The slewing motion is obtained from a flange-mounted motor and spur reduction gear, all gearing (with the exception of the final pinion) being totally enclosed. A brake is fitted on the motor extension shaft and a locking device to anchor the slewing portion of the crane when at rest.

LUFFING

Luffing is operated by a hydraulic cylinder and a ram with a piston head. Two pumps, mounted in tandem, have been fitted and they are driven by a common motor, as may be seen from Fig. 2 below. The direction of the fluid flow through the pumps is reversible, depending on the direction in which the motor is running. (The pump capacity can be adjusted to allow for the difference in swept volume between one end of the cylinder and the other.)

The method of operation consists of pumping oil into the cylinder at one end and metering it out through a pump at the other end. At all times the movement of the ram is dependent on the number of revolutions of the pumps; at no point is the ram free to take charge. A fill-up tank over the pumps enables the head of oil to be maintained, and a solenoid-operated valve is provided to " lock " the fluid when the motor is stopped. This valve is retarded by a dashpot to prevent sudden stopping due to rough handling, the actual checking of the jib being effected by the solenoid brake on the motor shaft. A relief valve fitted in the system prevents excessive pressure, which is restricted to 300 lb. per

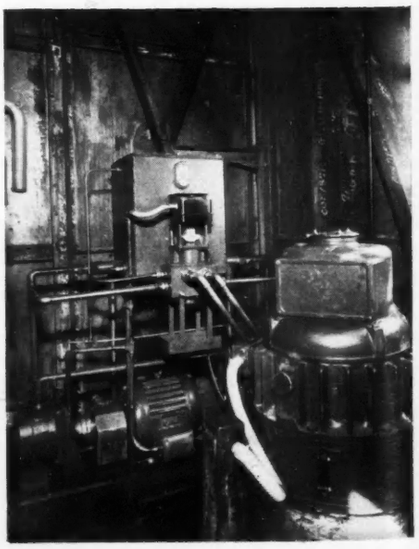

Fig. 2 The hydraulic luffing unit; luffing control is effected by metering the fluid both into and out of the cylinder so that the jib only moves in relation to the speed of the motor driving the pumps.

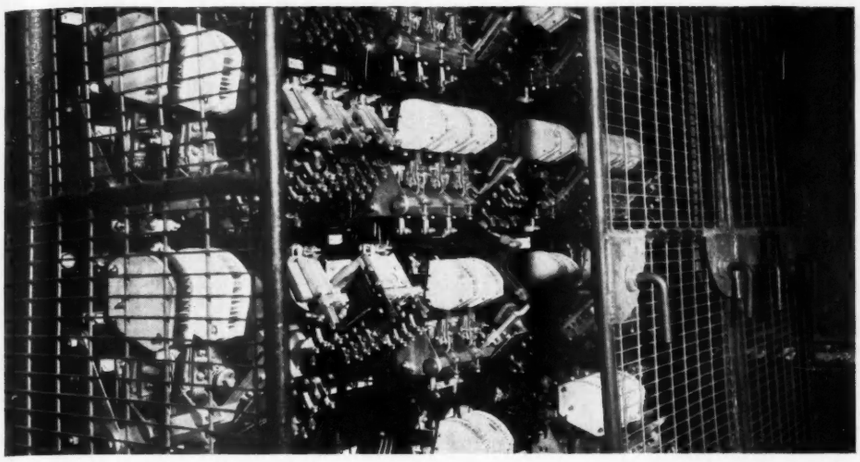

Fig. 3 Contactor control panel. The L.H.L. crane is essentially an electric crane with separate motors for each motion, but with the advantages of hydraulic luffing. Current supply is three phase, 50 cycles at 400/440 volts.

square inch. This valve operates if the luffing motion is reversed too suddenly and also provides an effective safety device when the ram reaches the end of its stroke. The cylinder and ram are of steel, the ram being protected from rusting by "Fescolising." In addition, a scraper ring is fitted outside the gland to prevent dust and dirt collecting there.

When the crane is not in use the jib is "luffed in" to the minimum radius and engaged with a stowing hook. To disengage the jib the luffing motion is inched in the "in" direction until the stowing hook can be lifted free. The stowing hook is partly balanced and controlled by a pull wire from the operator's cabin.

BRAKES

The hoist brake is of the usual Booth pattern, thrustor operated, of all-steel construction, with hardened and ground pins fitted in phosphor-bronze bushed holes. The linings are ground to form after riveting to the shoes to increase the life of the linings.

The slewing motion is fitted with a disc brake, mounted on the motor extension shaft. This brake is applied by means of three hydraulic cylinders actuated by a main pedal-controlled plunger. This arrangement ensures equal application of the disc and evens out the wear. The luffing motion is fitted with a "Perigrip" solenoid brake. Two travelling brakes are fitted, one on each motor shaft. These are Clyde pattern disc brakes with direct-current coils fed from a metal rectifier, the brakes being totally enclosed and protected from the weather.

COMPENSATING OVERWINDING GEAR

Compensating limit switches are fitted to both hoisting and luffing motions, and the compensation is effected by a gear-driven differential unit driven from both the hoisting and luffing motions. The drive is picked off the hoisting motion by means of bevel gears and off the luffing motion through a rack and pinion and a totally enclosed gear train. This compensating device enables full advantage to be taken of the extra height of lift available when the jib is working at short radii.

The compensating gear biases the hoist limit switch to suit the position of the jib, so that the hoist motion is stopped when the hook reaches a pre-determined distance from the jib head whatever the effective radius of the jib. Further hoisting is then prevented until the jib has been luffed "in," and luffing "out" is prevented until the hook is lowered. Similarly, luffing "out" is stopped should the hook approach too close to the jib head, and further hoisting is prevented. The unit also acts as a normal limit switch at the limits of travel of the luffing motion. An over-lowering switch can be incorporated, when specified, as an additional feature.

A radius indicator is fitted in the driver's cabin. This consists of a vertical plate with sliding indicator connected by a wire rope and pulleys to the jib so that the operator has a close up indication of the position of the jib.

ELECTRICAL SPECIFICATION

Motors.—The motors are crane pattern, slip-ring induction type, arranged to give a high starting torque. They will be fitted with ball and roller bearings and standard shaft extensions.

Control Gear and Electrical Protection.—There are two master controllers covering the hoist and slew motions, interconnected by a joystick so that a fore and aft movement of the joystick works the hoisting motion and a right and left movement actuates the slewing motion. The luff controller is also connected to a lever working in a fore and aft direction. Thus the crane driver has only two controls, one in each hand, for full operation of the crane on hoisting, slewing and luffing motions. The travelling motion is used for setting purposes and this is worked by a drum controller, crank-handle operated.

The contactor control panels (which include also overload and low-voltage protection) for hoisting and slewing motions are mounted towards the rear of the machinery house and protected with open-mesh covers and gates which, when open, give complete access to the panels. They are shown in Fig. 3. The gates are provided with a lock to prevent unauthorised access.

Lighting.—Lighting is provided from a separate circuit tapped off the live side of the panel and fed through a double-pole switch and fuses. The lighting includes two weatherproof 500 watt flood-lights, one lamp over the operator's cabin and arranged so that the operator can adjust the beam to suit requirements. The other light will be placed to suit customer's requirements. Cabin lights and two plug points for low-voltage handlamp and flexible lead have also been fitted.

Heating.—The heating circuit is tapped off the live side of the panel and fed through a double-pole switch fuse. Two 500 watt non-luminous metal-clad radiators are fitted.

Wiring.—The wiring throughout the crane will be carried out in 600 volt V.I.R. cable, run in conduit and troughing. A collector column is mounted on the centre pin to bring in the main current supply and for supplying the feeding points of the long-travel motors. The supply pick-up for the cranes will be by means of a trailing three-core flexible cable wound on an automatic cable-coiling drum mounted on the crane carriage.

PREVENTING BOILER SCALE

Trials on Three Types of Steam Plant

A report has been received from Centralube Limited, Great Western Trading Estate, Park Royal-road, London, N.W.10, of trials carried out on three types of steam raising plant to examine the effect of their product, Colo D.P. Graphite, on the prevention of scale and corrosion. This material also acts as an oil-free lubricant for the cylinders of steam engines as some is carried through in the steam.

The method of use of this graphite material is that a concentrated suspension is made by adding 2 oz. of Colo D.P. to 6 pints of distilled water and injecting doses at regular intervals. The trials were carried out at a gasworks where the boiler-feed was almost entirely fresh water which had a hardness of from 10 to 50 parts per million and a total alkalinity of from 100 to 150 parts per million, after having passed through a lime-soda plant.

For the first trials a hand-pump was installed to inject the Colo D.P. into a feed line supplying two Cochran boilers working at 60 lb. per square inch, and two Scotch Marine boilers working at 160 lb. per square inch. For the first week dosing was carried out every two hours at the rate of half a pint of mixture for every 10,000 lb. per hour of evaporation. After the first week, the interval between doses was doubled, in effect halving the dose. After 16 weeks steaming and 13 weeks dosing one of the Cochran boilers was opened for examination. This boiler had not been clean when put into operation, but was then found to be in good condition. Large areas of the shell were completely free from scale, and in other areas the scale was breaking away. Examination of the Marine boilers also showed good results; the water spaces behind the combustion chambers were almost free from scale, and all deposit had been removed from the threads on the stay tubes. There was a heap of loose scale on the bottom of each shell.

The second trial was made on a Babcock and Wilcox W.I.F. boiler rated at 20,000 lb. per hour at 160 lb. per square inch and 600 deg. F. Injection was made into the feed line just prior to the entry to the boiler drums, at the same rate as in the first trial. The boiler was dirty, and the scale in the boiler tubes very hard and as much as ¼ in. thick. The boiler was examined after three months and it was found that the scale had been loosened in some places and showed evidence that the graphite had penetrated to the tube wall.

In the third trial, which is now being carried out, injection is being made into the feed water at the recording tank so that the whole plant is being supplied at the same time. During the period of this trial, the lime-soda plant has been replaced by a base-exchange plant which has improved the quality of the feed supply. Since this changeover, the last two boilers opened for examination showed that the rate of loosening of scale had increased, and little more than brushing was required for their cleaning.

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ROD CONTROL IN REACTORS

A mechanism for actuating the combined control and shut off rods of nuclear reactors has been designed by Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, 17. It provides a slow "out" and two faster "in" speeds, and can hold the rod in any required position. It can also shut the reactor off independently of the electrical supply.

The mechanism consists of a synchronous control torque motor, fed from a variable frequency supply, driving through a 20 : 1 reduction gear on to a cable reel. The speed of the rods to the shut-off condition is controlled by a permanent magnet eddy current brake. Rod position is indicated through a geared magslip transmitter. The entire mechanism is dry lubricated by molybdenum disulphide.

DIESEL-MECHANICAL SHUNTING LOCOMOTIVES FOR NEW ZEALAND

A demonstration was recently given at the works of the manufacturers of the first of ten Diesel-mechanical locomotives that are being made by W. G. Bagnall Limited, Castle Engine Works, Stafford, for the New Zealand Government Railways. These locomotives are rated at 240 h.p. and are intended for shunting duties in the North Island; it is expected that the order will be completed in January next. A second order has also been placed with this firm for another seven locomotives, but these are to be of 150 h.p. and are intended for shunting work at the smaller wayside stations on both North and South Islands.

The general appearance of the 240 h.p. locomotive (which is a Bagnall design) is shown in the illustration below; this one was actually sent to the Tasman Pulp and Paper Company of New Zealand, but those for the Government Railways are the same except for a few details. Every attempt has been made to keep the exterior as smooth as possible and free from projections. Attention has also been paid to accessibility for maintenance and cleaning. Padded adjustable seats and arm rests are provided for the driver on both sides of the cab and air-operated wind-screen wipers are fitted back and front. Cab heating is provided, utilising the engine cooling-water system.

New Zealand Railways are built to a gauge of 3 ft. 6 in. and the overall width of these 0-6-0 locomotives is 8 ft. 6 in. They are 27 ft. 3½ in. over buffers and will negotiate curves of 3 chains radius. The overall height is 11 ft. 5½ in., weight in working order 30 tons, wheel diameter 3 ft. 3¾ in. and maximum speed 32·9 m.p.h. in either direction. The adhesion factor of 4·1 to 1, and the tractive effect varies from a maximum of 16,225 lb. to 2,132 lb. at top speed. The range of effort obtained in the various gears is shown in the diagram. The fuel tank capacity is 240 gallons, which is approximately enough for a full day's working.

SIX-CYLINDER ENGINE

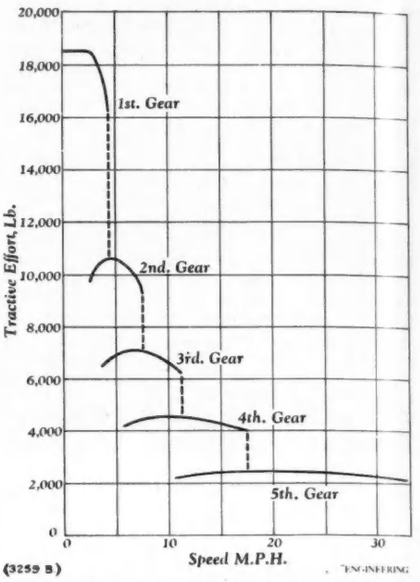
Power is supplied by a National M4AA6 engine, which has six vertical cylinders in line and operates on the four-stroke cycle. At the 12 hour rating, this engine develops 240 h.p. at 1,500 r.p.m. using light fuel not exceeding 45 seconds Redwood No. 1 at 100 deg. F. Consumption at full load is 0·375 lb. per b.h.p. per hour, increasing to 0·43 at half load. Electric starting is employed, following hand priming of the lubricating system. Cooling is effected by a Serck radiator designed for a maximum ambient air temperature of 95 deg. F. and a dissipation rating of 70 per cent. of full load. The cooling water is circulated by an engine-driven pump, and a fan, belt driven from the crankshaft, draws air through the radiator. Part of the radiator is used for cooling the lubricating oil.

The engine drives directly to a Vulcan-Sinclair fluid coupling, size 23, which has a bearing on the output side. Engine and coupling are together mounted on a sub-frame which is suspended from the main frames on four Silentbloc bushes. This mounting relieves the engine of shock, particularly during buffing operations. From the fluid coupling the drive is taken through Layrub universal couplings to the reduction gearbox, an air-operated unit made by the Self-Changing Gear Company, Limited. Five speeds are available with this box, which is of the Wilson epicyclic pattern, the three lower ones being engaged by brake bands, the fourth by a direct-drive plate clutch, and the fifth by an overdrive. The output shaft from the speed box is coupled to the reverse gearbox which drives on to the jack shaft with a reduction ratio of 9·82 to 1. This box incorporates a neutral lock which is used to disconnect the drive when the locomotive is being towed. An interlock prevents reversal while any one of the speed gears is engaged. This arrangement gives the locomotive the same range of speeds in both directions, which is a necessity for shunting. The final drive from the jackshaft is directly on to the coupling rods.

The locomotive is fitted with Westinghouse straight air and automatic brake equipment, with three storage receivers of 27 cub. ft. total capacity. Air is supplied from two compressors mounted one each side of the engine and belt driven from the free end of the crankshaft. In addition to the braking system, these supply air for the gearboxes, the sanding gear, the horn and the windscreen wipers. Train connections are included for working fitted stock. Pilot valves located beneath each driving position are operated by the dead-man's treadle plate, allowing a delay of six seconds between the release of the treadle and the application of the brakes. New Zealand standard brake blocks are employed, one to each wheel, and these can also be operated by an inclined handwheel set centrally in the cab.

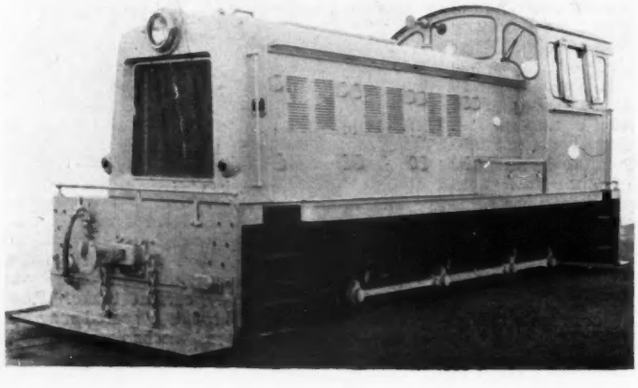
STRESS RELIEVED

The main frame of the locomotive is constructed of mild steel plates 1¼ in. thick, braced by a welded framework of cross stays riveted to them. All welding stresses are relieved by subsequent heat treatment. The buffer beams are 2½ in. thick and are riveted to the frames. There is a shunter's platform at each end with handrails extending the full width. In accordance with New Zealand standards, Janney Yoke type buffing and draw gear is used, with Spencer Moulton rubber springs. Side safety chains are also fitted. The wheels are of cast steel and have the tyres shrunk on and secured by Gibson retaining rings. The axles run in S.K.F. spherical-roller bearings housed in cast steel boxes. Both boxes and guides have magnanese steel liners which can be shimmed to take up wear. The boxes are carried on underslung laminated springs which have screw adjustment on the hangars to compensate for tyre wear up to a maximum of 1½ in., thereby maintaining a constant buffer height of 2 ft. 5½ in. from the rails. Jack brackets are riveted to the inside of both buffer beams to allow the unobstructed use of traversing jacks.



Tractive effort curves for 240 h.p. locomotive.

The cab is an enclosed welded structure, with doors that open inwards and sliding glass windows. All controls are duplicated so that the locomotive can be driven from either side as required. The controls are mounted on a flat desk which extends the full width of the cab. They consist of engine throttle, change-speed gear lever, reverse gear lever and the two brake levers for train and engine. An instrument panel is mounted above the desk. The dead-man's treadle plates are mounted at each side, along the side walls of the cab. Electric lighting is used, and is provided by an engine-driven dynamo and batteries which are contained in boxes mounted on both sides of the locomotive. One can be seen in the illustration, immediately in front of the cab. There is a socket for an inspection lamp inside the engine housing. As mentioned earlier, attention has been paid throughout to ease of maintenance, and in pursuance of this all piping and conduit running inside the housing has been colour coded for identification.



Diesel shunting locomotive of 240 h.p., fitted with mechanical transmission, including a five-speed gearbox which can be used in both directions of travel.

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PLASTICS MOULDING MATERIALS

Two plastics materials previously obtainable only in America are now to be produced in Great Britain. The polystyrenes Styron 475 and Styron 666 are the main products of Distrene Limited, Devonshire House, London, W.1, whose factory is at Barry, Glamorgan. The company is jointly owned by the Distillers Company, Limited, and the Dow Chemical Company, Midland, Michigan, U.S.A., and sales of Styron will be promoted and directed by British Resin Products Limited.

Both products are moulding materials made in a range of opaque and translucent colours, and the principal difference between them is that Styron 475 is toughened, and in consequence has a lower tensile strength but a considerably higher impact strength than Styron 666. Comparative figures for Izod impact strength in lb. per inch notch are: 475, 1·0 to 1·8; 666, 0·25 to 0·5. The softening point of 475 is 85 deg. C. and of 666 88 to 92 deg. C. Both are water resistant and non-toxic and have good electrical properties. Typical uses are food containers, refrigerator components, tubing, packaging and battery boxes.

LOADING THE ATLANTIC TELEPHONE CABLE

Special Equipment at Erith

H.M.T.S. Monarch sailed from Erith, Kent, on July 30 with 1,300 nautical miles of Atlantic telephone cable with 29 flexible repeaters on board. This cable has been joined to the 200 miles of cable that was laid from Newfoundland earlier this year, and has been laid across the deepest part of the Atlantic to Rockall, about 500 miles from the Scottish coast. It forms the first deep-sea section of the cable which now links Great Britain, Canada and the United States by submarine telephone. The cable and its repeaters have already been described in ENGINEERING, vol. 177, page 452 and vol. 178, page 638 (1954). The final splice was made off the Argyllshire coast on September 26, and the cable was declared "well and truly laid." Only one-way transmission is provided by the flexible type repeaters installed in this cable, and so only one-way conversation is possible until the second cable is laid next year to complete the circuit.

The conventional method of loading the cable from the storage tanks on land into the ship's tanks by means of suspended rollers was not practicable, and special equipment which can convey three lines of cable simultaneously has been erected at the Erith works of the cable manufacturers, Submarine Cables, Limited. (These works, which were specially built for the purpose, were described in ENGINEERING, vol. 178, page 740.)

From the shore cable tanks the cable first travels over a bridge 178 ft. long and then over a span of 260 ft. to a tower erected in the River Thames. From this point it has to travel over a distance ranging from 200 ft. to 350 ft., according to the point of entry into the ship and the position in which the ship is moored. It is essential that in no circumstances should the cable be bent round a radius of less than 3 ft. 6 in. to avoid damaging the repeaters, and the loading equipment has been designed to meet this requirement. It has also been arranged to comply with the requirements of the Port of London Authority for navigation to adjoining wharves. The towers and bridge were designed, fabricated and erected by Sheppard and Sons, Limited, Bridgend, Glamorganshire, in collaboration with their consulting engineer, Mr. Clifford E. Saunders, M.I.Struct.E., A.M.Inst.W., and Submarine Cables, Limited. The piling and foundation work was undertaken by John Mowlem and Company, Limited, with Sir William Halcrow and Partners as consultants. In the illustration, the catenary ropes are in place between the wharf and the river tower, and are being slung from the latter to the vessel.

From the wharf gantry, the telephone cable is carried to the cable layer by rollers slung from catenary wires; the outer span is being hauled into position.

The bridge, which is tapered in plan and is of riveted and welded construction, is supported on a steel tower and a lattice stanchion at the tank-house end, and at the other end it is carried by a steel tower, 50 ft. high, built at the edge of the wharf. Rocker bearings are provided at one end of the bridge to allow for expansion. At the top of the wharf tower there is a bank of sheaves, 7 ft. in diameter, power driven, to assist when necessary in the hauling of the cable from tanks to ship. Small idler sheaves at 6 ft. centres support the cable along the whole length of the bridge floor.

The bridge span from the tank-house to the edge of the wharf is a permanent structure, but beyond this point the cable is carried over two spans which are demountable. From the wharf tower a span of 260 ft. takes the cable to a river tower, 60 ft. high, built on piled dolphin foundations. Three lines of wire rope, with sheaves at 6 ft. centres, are used to support the cable over this span. From the river tower to the ship a similar arrangement is used, the supporting ropes being attached temporarily to the ship by an anchorage designed by Submarine Cables, Limited. This anchorage incorporates nylon ropes, which give a certain amount of elasticity to allow for movements of the ship due to the tide or to passing traffic. Calibration of the nylon ropes enables the tension in the wire ropes and the loading on the towers and foundations to be kept within safe limits.

The outer spans, from the river tower to the ship, are arranged to take up any position within an angle of 25 deg. on either side of the centre-line of the tower to allow for alternative points of entry of the cable into the ship for different positions of the ship at the mooring dolphins, and for three lines of cable to be passed simultaneously.

Haulage of the cable is by means of gear placed on the ship, supplemented by haulage gear of similar design in the wharf tower already mentioned. This consists of large-diameter grooved pulleys, driven by electric motors through reduction gear, with a small guide pulley which grips the cable against the groove. The cable is treated with whitewash to prevent the bitumen covering from sticking and becoming damaged. A continuous electrical check is made of the cable while it is being loaded to detect any faults or damage. A similar check is made while it is actually being laid, and all joints are X-rayed before being passed.

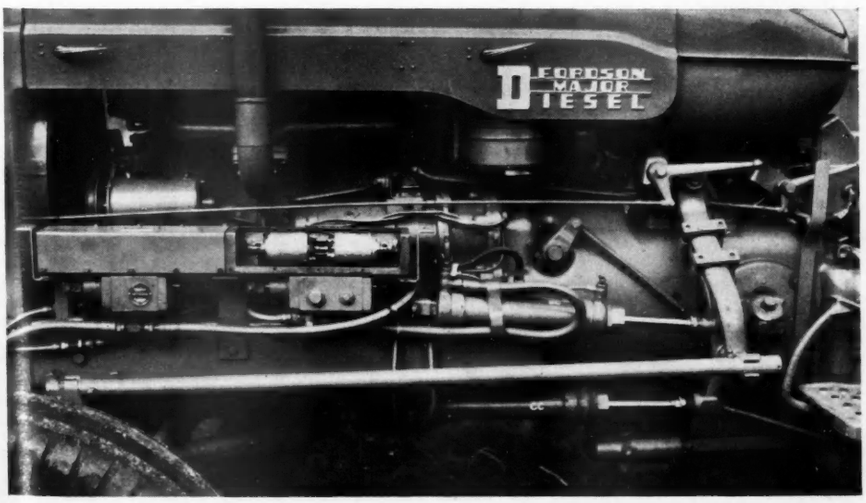
* * *

TRACTOR WITH REMOTE CONTROL

As the basis of a new approach to sales demonstration, the Ford Motor Company, Limited, Dagenham, Essex, have recently introduced a radio-controlled version of their Fordson Major Diesel tractor, which can be remotely started, steered and stopped by means of a small handset and battery-operated transmitter. Believed to be the first radio-controlled tractor to be shown in this country, it is not intended for production, but the possibility of its future application to such duties as the transport of dangerous radioactive materials in atomic plants has not been overlooked. It will serve as a focal point for field demonstrations of Fordson tractors during the next twelve months.

The controls are arranged to provide the following movements: steering left, steering right, clutch out, implements raise, implements lower, and engine stop; the last movement also serves as a safety device in the event of any failure. Remote control is effected by means of a simple transmitter working at a frequency of 27·12 Mc, which provides six separate non-simultaneous channels by means of audio-frequency modulation of the carrier. The receiver has tuned-reed output relays for reception of the different signals, and these in turn operate secondary relays which complete circuits linking the 12 volt tractor battery to the control solenoids. These govern the action of hydraulic cylinders associated with the six functions listed. The system incorporates a solenoid-operated by-pass valve which effects a short circuit of the hydraulic pump when no hydraulic power is required, thus minimising waste and dispensing with the need for an oil cooler.

The illustration (left) is a close-up view of the steering control unit, showing electrical apparatus and hydraulic cylinder; the cylinder is connected to the steering drop arm. By-pass taps permit manual steering when required. The design and installation of the remote-control equipment was carried out by Fenlow Products Limited, Weybridge, Surrey.



Solenoid-operated hydraulic steering system of a radio-controlled Fordson Major Diesel tractor, which is to be used by the Ford Motor Company for demonstration purposes.

In Parliament

AREA RULE IN AIRCRAFT DESIGN

Among questions of technical interest put to Ministers during the past week was one concerning the operation of the Area Rule in aircraft construction. The questioner asked the Minister of Supply if he was aware that, since 1952, several United States aircraft had come into service embodying that principle, with an increase in speed estimated to be of the order of 25 per cent.

In a written reply, Mr. Reginald Maudling stated that a report on the Area Rule was released to us by the Americans in January, 1953, and circulated by his Department to all designers of British military aircraft. The Area Rule, in effect, was a method of applying to the design of supersonic aircraft complicated mathematical theories of drag on which a great deal of work had been, and was being, done in this country. The increase in speed its application could give depended, of course, upon the quality of the original design of any given aircraft and the speed range for which it was intended.

All current British designs had been examined in the light of the new rule but few improvements had resulted, because it was of benefit only in the case of aircraft designed for supersonic speeds and because British supersonic projects had been found already to conform closely to Area Rule principles.

REDUCTION OF AIR POLLUTION

The second reading of the Clean Air Bill was moved by Mr. W. F. Deedes, the Parliamentary Secretary to the Ministry of Housing and Local Government, on November 3. He said that the Bill was based on the recommendations of the committee presided over by Sir Hugh Beaver, which reported their conclusions just a year ago. The Bill prohibited the emission of dark smoke from chimneys, railway engines and shipping. It was accepted that dark smoke was a nuisance and, generally, quite unnecessary. Given sound equipment and careful operation, bituminous coal could nearly always be burned in industrial furnaces without producing more than a light haze of smoke.

The Bill demanded the efficient use of efficient plant, that industrial furnaces installed in the future should be operated, as far as was practicable, without emitting smoke, and that the discharge of grit and dust from furnaces should be reduced. These provisions would involve the improvement and alteration of many industrial plants. It was on this account that the Beaver committee had recommended a seven-year period of grace, and the Government had accepted that proposal. The prevention of domestic smoke would be a major operation and would be achieved gradually.

Criticisms of the Bill seemed to be centred mainly on suggestions that its provisions were not strong enough. One member complained that it contained so many " savers and waivers " as to render it abortive unless the greatest vigilance was exercised. It was claimed that clause 1 (3) prohibited dark smoke from chimneys and then gave any factory owner the chance to plead that the fuel used was unsuitable.

Several members agreed with a suggestion that the seven-year dispensation period was far too long and one member expressed his intention to move an alteration, in the committee stage, to three years. To be effective, a Clean Air Council should be provided as part of the legislative instrument and not by administrative action. The Beaver Committee had asked emphatically that every local authority should submit to the Minister an annual report of progress, but there was no such requirement in the Bill. Another point was that the tax incentives recommended by that Committee, in respect of industrial fuel-economising plant, should have been introduced into the Finance Bill, which had succeeded the autumn Budget.

One member asked that the Bill, which later passed its second reading, should provide for the compulsory electrification of factories and workshops, and that the railways should be electrified and not "dieselised."

An extended summary of the Bill is contained in ENGINEERING for August 5, 1955, vol. 180, page 168. The Beaver Report was summarised in ENGINEERING of December 3, 1954, vol. 178, page 718, and editorial comment appeared on page 715 of the same issue.

Research Helicopter

The contract with Hunting Percival Aircraft Limited for the construction of a research helicopter was placed by the Ministry of Supply at the end of 1951. The Minister, Mr. Reginald Maudling, stated that the object of the project was to explore the possibilities of a new form of helicopter propulsion. The experimental aircraft was virtually complete and ground running was expected to start very shortly. Unless any unforeseen snag occurred during ground running, it should start flying soon afterwards. On the subject of cost, Mr. Maudling said it was not the normal practice to make public details of the sums of money paid to individual firms.

Technical Assistance under Colombo Plan

Sir Edward Boyle, Bt., Economic Secretary to the Treasury, wrote that the present Colombo Plan would run until June 30, 1957. It was unanimously agreed at the Singapore Conference that the Plan should continue until June 30, 1961. It was made very clear at Singapore that technical assistance on a generous scale was of fundamental importance to the success of the Plan. Lord Reading, Minister of State for Foreign Affairs, had announced at the Conference the Government's decision to increase their commitment for technical assistance to £7 million over a period of seven years from April next.

Location of Atomic Power Stations

Questions regarding the progress being made with the Government's £300 million programme of nuclear-power development drew a written reply from Mr. L. W. Joynson-Hicks, Parliamentary Secretary to the Ministry of Fuel and Power, that the primary purpose of the proposed 12 atomic-power stations to be built in Britain during the next ten years would be to generate electricity for the country's general needs. So far, progress had been mainly in station design work and the search for sites. The Central Electricity Authority had already selected sites for the first two stations, one at Bradwell in Essex and the other at Berkeley in Gloucestershire. They had four more sites under urgent consideration and were pressing on with the search for others.

Dartford Tunnel and Pelham Bridge Scheme

Mr. John Boyd-Carpenter, the Minister of Transport and Civil Aviation, stated that the existing plant and equipment for the proposed Dartford Tunnel was being overhauled. Tenders for the main tunnelling work would be invited very soon and the work should start next spring. Answering another question, the Minister said he saw no reason why the Lincoln Pelham Bridge scheme should be delayed.

Electricity Supply Industry's Organisation

Mr. Joynson-Hicks said in a written answer that the committee under the chairmanship of Sir Edwin Herbert, which was now investigating the organisation of the electricity-supply industry, was expected to report by the end of the year.

Steel Plates for Shipyards

Mr. A. R. W. Low, Minister of State to the Board of Trade, said in a written answer that he had not recently heard of difficulties in the delivery of steel plates to Sunderland shipyards, but undertook to ask the Iron and Steel Board to look into the matter if details were sent to him. In answer to a separate question, he wrote that stocks of steel at consumers' works were no higher in relation to consumption at the end of June than they were at the end of 1954. Although the high level of industrial demand was causing some difficulties in supply, they were not such as to justify the re-imposition of control.

Sulphur Production

The President of the Board of Trade, Mr. Peter Thornycroft, wrote that he understood the capacity for the production of sulphur in this country, mainly from imported mineral oils, had been increased several fold during the last five years. The increase continued. Moreover, we were now better protected against a shortage from overseas, through the very large additions to our sulphuric acid capacity of plant using pyrites, anhydrite or spent oxide instead of sulphur.

Atomic Energy Conference Report

Asked how many copies of the proceedings of the International Conference on the Peaceful Uses of Atomic Energy had been ordered from the Stationery Office at the special price of £39 each, Mr. Butler replied that 41 sets and 80 individual volumes had been ordered to date. The report would be widely publicised before its publication on January 1 next, but the United Nations Organisation did not propose to publish a short summary.

Science Graduates

Mr. H. Brooke, Financial Secretary to the Treasury, said there were about 80,000 graduates in pure science in the United Kingdom, of whom one-third were employed in teaching and one-eighth were in the public service and with the Atomic Energy Authority.

The Budget Debate

Budget proposals and the economic situation continued to occupy a major place in the business of the House of Commons during the past week. A number of criticisms of the Government's suggested remedies were put forward. One point emphasised by the Opposition was that the country was spending large sums in dollars to import steel sheets to make motors cars and that, if these imports were to be tied to export performance, the Government would get the increase in motor-car exports which they wanted.

On October 31, Mr. R. A. Butler, the Chancellor of the Exchequer, replying to a censure motion accusing the Government of incompetence and neglect in their economic and financial policy, stressed the expectations of the Government that, as a result of raising the Bank rate, starting credit control in February, curtailing hire purchase, and budgeting for what was clearly going to be a very large surplus, they would have inflation under control. Statistics indicating industrial production for the third quarter of this year were still provisional, but there was absolutely no doubt that the country's trade figures and the balance of payments were affected badly by the dock strike. But the rise in production was now continuing.

In his April Budget, Mr. Butler said, he had estimated that fixed investment would increase by at least the same amount as last year, and that stock piling would go on at the same rate. In fact, the boom in investment had been stronger than was foreseen. This was not a matter for condemnation. It was common ground in the House that investment required stimulation. The motion was later defeated by a substantial majority.

In a debate in the House of Lords on the Government's Budget policy, Earl De La Warr pointed out that trade unionists in the United States were just as tough as their British counterparts in making sure that they received their fair share of profit, but high production and high profits were the joint object of both employers and employed. If the same attitude could be obtained in Britain, in place of the attitude that the boss was the enemy, there would be no need for any more autumn Budgets.

NOTICES OF MEETINGS

Aslib

LONDON
"The Chemical Abstracts Service and Its Plans," by Dr. E. J. Crane. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Wed., Nov. 16, 6 p.m.*

Association of Supervising Electrical Engineers

LONDON
Discussion on "Electric Floor and Wall Warming." Central London Branch. 7 Victoria-street, S.W.1. Mon., Nov. 14, 6.15 p.m.
"Fault Protection in Large Distribution Networks," by J. E. Fitzpatrick. National Lecture. Magnet House, Kingsway, W.C.2. Tues., Nov. 15, 6.30 p.m.*

Building Centre

LONDON
Films: "Wonder Rock" and "Paramount Dry Partition." Wed., Nov. 16, 12.45 p.m.

Chemical Engineering Group

BRADFORD
"A Theory of Drying Sheet Materials, Using Heated Cylinders," by A. H. Nissan. Technical College, Bradford. Mon., Nov. 14, 7 p.m.

Chemical Society

LONDON
"Some Developments in the Study of Physical Adsorption," by Professor D. H. Everett. Imperial College of Science and Technology, South Kensington, S.W.7. Thurs., Nov. 17, 7.30 p.m.

Diesel Engine Users Association

LONDON
"Failures of Diesel Engine Valve Springs with Particular Reference to Fatigue," by J. H. Darley. Caxton Hall, Victoria-street, S.W.1. Thurs., Nov. 17, 2.30 p.m.

Gauge and Tool Makers' Association

LONDON
Annual General Meeting at 2 p.m. Preceded by an informal luncheon at 12.30 for 1 p.m. for members only. Savoy Hotel, Strand, W.C.2. Wed., Nov. 16.

Illuminating Engineering Society

BRADFORD
"Modelling with Light and Colour," by J. W. Howell. Leeds Centre. Church House, North Parade, Bradford. Wed., Nov. 16, 7 p.m.
SHEFFIELD
"Interior Decoration and Lighting," by J. Wilson. Sheffield Centre. The University, Western Bank, Sheffield. Mon., Nov. 14, 6.30 p.m.

Incorporated Plant Engineers

BLACKBURN
"Rockets and Space Travel," by E. Burgess. Blackburn Branch. Golden Lion Hotel, Blackburn. Thurs., Nov. 17, 7.30 p.m.
BRISTOL
"Mass Emigration and the Engineer," by I. F. G. McVicker. Western Branch. Royal Fort, Bristol. Wed., Nov. 16, 7.15 p.m.
DUNDEE
"Fire Prevention," by N. Hastie. Dundee Branch. Mathers Hotel, Dundee. Mon., Nov. 14, 7.30 p.m.

Institute of British Foundrymen

LONDON
"CO_2 Process," with film, by A. Tipper. London Branch. Waldorf Hotel, Aldwych, W.C.2. Wed., Nov. 16, 7.30 p.m.
COVENTRY
"Hot-Blast Cupolas," by W. J. Driscoll. Coventry Section. Coventry Technical College, Coventry. Tues., Nov. 15, 7.30 p.m.

Institute of Fuel

MANCHESTER
"The Effect of Coal Quality on the Efficiency of a Shell Boiler Equipped with a Travelling-Grate Stoker," by E. J. MacDonald and M. V. Murray. North Western Section. Engineers' Club, Albert-square, Manchester. Wed., Nov. 16, 2.30 p.m. Preceded by Members' luncheon at 1 p.m.
LEEDS
Discussion on "Nuclear Power Stations." Yorkshire Section. Hotel Metropole, Leeds. Wed., Nov. 16, 2.30 p.m.

Institute of Industrial Supervisors

LIVERPOOL
"Inspection Instruments," by S. Ellerby. Merseyside Section. Stork Hotel, Liverpool. Wed., Nov. 16, 7.45 p.m.

Institute of Petroleum

MANCHESTER
"Solid Lubricants," by E. A. Smith. Northern Branch. Engineers' Club, Albert-square, Manchester. Tues., Nov. 15, 6.30 p.m.

Institute of Road Transport Engineers

LONDON
"Use of Light Alloys in Vehicle-Body Building," by H. W. LeGood. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Thurs., Nov. 17, 6.30 p.m.
LEEDS
"World's Largest Walking Dragline Excavator," by C. McL. Cameron. Yorkshire Centre. Great Northern Hotel, Wellington-street, Leeds. Thurs., Nov. 17, 7.30 p.m.
MANCHESTER
"The Commer T.S.3 Two-Stroke Diesel Engine," by E. W. Coy. East Regional Centre. Houldsworth Hall, 90 Deansgate, Manchester. Mon., Nov. 14, 7.30 p.m.

Institution of Chemical Engineers

LONDON
"An Assessment of Dry-Blending Equipment," by F. E. Adams and A. G. Baker. Geological Society, Burlington House, Piccadilly, W.1. Tues., Nov. 15, 5.30 p.m.
LEEDS
"Recent Developments in Pressure Vessel Construction," by S. H. Griffiths. North Western Branch. The University, Leeds. Wed., Nov. 16, 7 p.m.

Institution of Civil Engineers

LONDON
"The Development of a Mechanical Draught Water-Cooling Tower," by L. Gilling Smith and G. J. Williamson. Tues., Nov. 15, 5.30 p.m.*
LIVERPOOL
Chairman's Address by J. D. T. Firth. North Western Association. 9 The Temple, 24 Dale-street, Liverpool. Wed., Nov. 16, 6 p.m.
MANCHESTER
Students' Symposium. North Western Association. Engineers' Club, Manchester. Thurs., Nov. 17, 6.30 p.m.
BIRMINGHAM
Lecture by H. K. Goodger, holder of 1954 Culman Travelling Fellowship. Midlands Association. James Watt Memorial Institute, Birmingham. Tues., Nov. 15, 6 p.m.*

Institution of Electrical Engineers

LONDON
Discussion on "Is the Engineer Broad Enough in His Outlook?" opened by Dr. P. Dunsheath. Mon., Nov. 14, 5.30 p.m.*
"An Electrolytic-Tank Equipment for the Determination of Electron Trajectories, Potential and Gradient," by Dr. D. L. Hollway; and "A Method of Tracing Electron Trajectories in Crossed Electric and Magnetic Fields," by Dr. D. L. Hollway. Measurement and Radio Sections Joint Meeting. Tues., Nov. 15, 5.30 p.m.*
Discussion on "Thermal Rating of Transformers," opened by R. A. Grierson. Supply Section. Wed., Nov. 16, 5.30 p.m.*
"Timing the Operation of Control Systems Associated with Rotating Equipment," by C. Cuthbert and D. A. Picken; and "The Dynamic Braking of Induction Motors," by Dr. D. Harrison. Utilization Section. Thurs., Nov. 17, 5.30 p.m.*
BRISTOL
"Electrification of the Manchester-Sheffield-Wath Lines, Eastern and London Midland Regions, British Railways," by J. A. Broughall and K. J. Cook. Western Centre. Electricity House, Colston-avenue, Bristol. Mon., Nov. 14, 6 p.m.
HOVE
"Electrical Energy from the Wind," by E. W. Golding. Southern Centre. Offices of the South Eastern Electricity Board, Hove. Wed., Nov. 16, 6.30 p.m.
NEWCASTLE-UPON-TYNE
"A Transatlantic Telephone Cable," by Dr. M. J. Kelly, Sir Gordon Radley, G. W. Gilman and R. J. Halsey. North Eastern Centre. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Mon., Nov. 14, 6.15 p.m.

Institution of Engineering Inspection

WOLVERHAMPTON
"Heat Treatment of Steel," by A. D. Hopkins. Wolverhampton Branch. Compton Grange, Compton-road, Wolverhampton. Mon., Nov. 14, 7.30 p.m.

Institution of Engineers-in-Charge

LONDON
"Fault Protection in Large Distribution Networks," by J. E. Fitzpatrick. Magnet House, Kingsway, W.C.2. Tues., Nov. 15, 6.30 p.m.*

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
"Experiments on Box Girders: Some Contributions to the Theory of Ship Structures," by Dr. S. R. Sparkes and Dr. J. C. Chapman. Tues., Nov. 15, 7.30 p.m.

Institution of Heating and Ventilating Engineers

PRESTON
"Thermal Insulation," by R. Clegg. Manchester Branch. County Offices, Preston. Fri., Nov. 18, 6.30 p.m.

Institution of Locomotive Engineers

LONDON
"Railway Breakdown Organisation and Equipment in Use on the London Transport System," by G. S. Bingham. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Wed., Nov. 16, 5.30 p.m.*

Institution of Mechanical Engineers

LONDON
Discussion on "Stress Analysis by Brittle Lacquers: Techniques and Applications." Applied Mechanics Group. Tues., Nov. 15, 6.45 p.m.
"Plastics in Aircraft Construction," by A. W. Rawe. London Graduates' Section. Thurs., Nov. 17, 6.30 p.m.*
Thomas Hawksley Lecture on "Properties of Matter at High Pressures," by Professor D. M. Newitt. Fri., Nov. 18, 5.30 p.m.*
COLCHESTER
Chairman's Address on "Aero Engines: Past, Present and Future," by Professor A. D. Baxter. Eastern Branch. Red Lion Hotel, Colchester. Thurs., Nov. 15, 7.30 p.m.
DERBY
"Fatigue of Metals," by Professor A. E. Pope. Derby A.D. Centre. Midland Hotel, Derby. Mon., Nov. 14, 7.15 p.m.
LIVERPOOL
"Influence of Some Design Factors on the Characteristics of Ball Bearings and Roller Bearings at High Speeds," by A. Fogg and J. S. Webber; and "Some Further Tests on High-Speed Ball Bearings," by Dr. F. T. Barwell and M. J. Hughes. North Western Branch. 9 The Temple, 24 Dale-street, Liverpool. Wed., Nov. 16, 6 p.m.
LUTON
"Disk Brakes," by F. G. Parnell and F. J. Bradbury. Luton A.D. Centre. Town Hall, Luton. Mon., Nov. 14, 7.30 p.m.

Institution of Mining and Metallurgy

LONDON
Papers on "Oxygen in Molten Lead" and "Airborne Dusts." Geological Society, Piccadilly, W.1. Thurs., Nov. 17, 5 p.m.*

Institution of Production Engineers

DERBY
"Automatic Inspection," by J. A. Sargrove. Derby Section. College of Art, Derby. Mon., Nov. 14, 7 p.m.
NORWICH
"Jobbing Foundry Work To-Day," by A. Talbot. Norwich Section. Assembly House, Theatre-street, Norwich. Wed., Nov. 16, 7.30 p.m.
SHEFFIELD
"Bar Mills," by W. Udall. Sheffield Section. Grand Hotel, Sheffield. Mon., Nov. 14, 6.30 p.m.

Institution of Railway Signal Engineers

YORK
"Productivity," by E. W. Etchells. British Railways Signals School, Toft Green, York. Wed., Nov. 16, 5.30 p.m.*

Institution of Structural Engineers

BRISTOL
"Shuttering," by C. Parry. Western Counties Branch. The University, Bristol. Thurs., Nov. 17, 6 p.m.
LEEDS
"The Allt-Na-Lairige Prestressed-Concrete Dam," by J. A. Banks. Yorkshire Branch. The University, Leeds. Wed., Nov. 16, 6.30 p.m.

Institution of Water Engineers

LONDON
Film Display. Institution of Civil Engineers, Great George-street, S.W.1. Wed., Nov. 16, 2.30 p.m.

Iron and Steel Institute

LONDON
Autumn General Meeting. Wed., Nov. 16, and Thurs., Nov. 17, 10 a.m. and 2.30 p.m.
"Russian Iron and Steel Industry," by Sir Robert Shone and W. F. Cartwright. Seymour Hall, Seymour-place, St. Marylebone, W.1. Wed., Nov. 16, 6 p.m.* Admission by ticket.

Junior Institution of Engineers

LONDON
Chairman's Address on "Automation: What Are Its Problems?" by A. S. Ladley. Fri., Nov. 18, 7 p.m.

Manchester Association of Engineers

MANCHESTER
"Welding: Is it a Menace?" by Dr. F. Koenigsberger. Engineers' Club, Manchester. Fri., Nov. 18, 6.45 p.m.

Modular Society

LONDON
"Modular Co-ordination: An Industrial Tool," by Lennart Bergvall. 66 Portland-place, W.1. Tues., Nov. 15, 7 p.m.

Reinforced Concrete Association

LONDON
"The Place of Cement in Concrete Making," by E. S. Shellard. 11 Upper Belgrave-street, S.W.1. Wed., Nov. 16, 6 p.m.*

Royal Aeronautical Society

LONDON
"The Planning of Experiments," by Sir Ronald A. Fisher. Tues., Nov. 15, 7 p.m.

Royal Institution

LONDON
"Automatic Control and Production"—IV, by R. H. Macmillan. Tues., Nov. 15, 6 p.m.
"Large-Scale Weather Processes"—III, by Dr. R. C. Sutcliffe. Thurs., Nov. 17, 6 p.m.

Royal Meteorological Society

LONDON
Various short papers. Wed., Nov. 16, 5 p.m.*

The Royal Society

LONDON
Special General Meeting to consider the Annual Report of the Council. "Physics at the Radar Research Establishment, Malvern," by R. A. Smith. Thurs., Nov. 17, 4.30 p.m.*

West of Scotland Iron and Steel Institute

GLASGOW
"The Metallurgy of Nuclear Power Production," by Dr. A. B. McIntosh. Fri., Nov. 18, 6.45 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting. An asterisk (*) is placed where it is understood that tea is available prior to the time stated.

Aslib, 4 Palace-gate, London, W.8. (WEStern 6321.)
Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1. (LANgham 5927.)
Building Centre, 26 Store-street, London, W.C.1. (MUSeum 5400.)
Chemical Engineering Group, 56 Victoria-street, London, S.W.1. (VICtoria 6161.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Diesel Engine Users Association, 56 Victoria-street, London, S.W.1. (VICtoria 6161.)
Gauge and Tool Makers' Association, Standbrook House, 2-5 Old Bond-street, London, W.1. (HYDe Park 3451.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 48 Drury-lane, Solihull, Birmingham. (Solihull 3021.)
Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester 3. (Blackfriars 6178.)
Institute of Fuel, 18 Devonshire-street, Portland-place, London, W.1. (LANgham 7124.)
Institute of Industrial Supervisors, 24 Albert-street, Birmingham, 4. (Midland 6971.)
Institute of Petroleum, Manson House, 26 Portland-place, London, W.1. (LANgham 2250.)
Institute of Road Transport Engineers, 69 Victoria-street, London, S.W.1. (ABBey 6248.)
Institution of Chemical Engineers, 56 Victoria-street, London, S.W.1. (VICtoria 6161.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Engineering Inspection, 28 Victoria-street, London, S.W.1. (ABBey 3794.)
Institution of Engineers-in-Charge, 100 Earlsfield-road, London, S.W.18. (BATtersea 1394.)
Institution of Engineers and Shipbuilders in Scotland, 39 Elm-Bank-crescent, Glasgow, C.2. (Central 5181.)
Institution of Heating and Ventilating Engineers, 49 Cadogan-square, London, S.W.1. (SLOane 3158.)
Institution of Locomotive Engineers, 28 Victoria-street, London, S.W.1. (ABBey 6672.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Mining and Metallurgy, 44 Portland-place, London, W.1. (LANgham 3802.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Institution of Railway Signal Engineers, Euston House, Eversholt-street, London, N.W.1.
Institution of Structural Engineers, 11 Upper Belgrave-street, London, S.W.1. (SLOane 7128.)
Institution of Water Engineers, Parliament Mansions, Abbey Orchard-street, London, S.W.1. (ABBey 6740.)
Iron and Steel Institute, 4 Grosvenor-gardens, London, S.W.1. (SLOane 0061.)
Junior Institution of Engineers, Pepys House, 14 Rochester-row, London, S.W.1. (VICtoria 0786.)
Manchester Association of Engineers, 18 Booth-street, Manchester 2. (Central 1717.)
Modular Society, 22 Buckingham-street, London, W.C.2. (TRAfalgar 4567.)
Reinforced Concrete Association, 94-98 Petty France, London, S.W.1. (ABBey 4504.)
Royal Aeronautical Society, 4 Hamilton-place, London, W.1. (GROsvenor 3515.)
Royal Institution, 21 Albemarle-street, London, W.1. (HYDe Park 0669.)
Royal Meteorological Society, 49 Cromwell-road, South Kensington, London, S.W.7. (KENsington 0730.)
Royal Society, Burlington House, Piccadilly, London, W.1. (REGent 3335.)
West of Scotland Iron and Steel Institute, 39 Elmbank-crescent, Glasgow, C.2. (Central 5181.)

THE HUMAN ELEMENT

A dusty answer from the T.U.C.—Large pay claim in the offing.—Keep accidents off the site and shop.—"Automation" continues to hold the stage.—National service under fire.—Grandfather's, father's and our snobbery.

* * *

T.U.C. on the Budget

The Government paid the Trades Union Congress a rather unique compliment when it introduced the autumn Budget two weeks ago by offering the T.U.C. an immediate conference on its implications. The men of Smith Square returned rather a dusty answer. They accepted the offer of a meeting but they followed it with a quick and critical comment on the Chancellor's proposals. They did it with a brusqueness which is not associated these days with the T.U.C.

Behind their attitude lies an important difference of principle between themselves and the Government. It was no mere gesture of diplomacy which made the T.U.C. leaders confer with representatives of the Labour Party before they went on to meet the Government. The T.U.C. and the Labour Party are closer together on broad economic policy than on most subjects—due to some extent to the fact that one of the assistant secretaries is an orthodox socialist with a grasp of its theory and is also exceedingly articulate on economic matters. Both the T.U.C. and the Labour Party want planning to take care of economic problems. They dislike flexibility of prices and the mechanism of the free market. In the context of the present economic situation they would go for controls, especially control of imports. This is the one weapon which Mr. Butler has said he will not use. It now remains to be seen if the fact that they differ seriously in principle from the Government on economic policy makes the T.U.C. reluctant to advise unions to exercise discretion in the new round of wage claims. In this issue, realism rather than theory may well win the day.

* * *

Accidents and Inefficiency

Accidents seldom happen in places of work that are run efficiently and there is a close relationship between accident rates and productivity. Morale and leadership are factors which influence industrial safety far more than rules and regulations. Sir Walter Monckton, speaking at the Industrial Safety Conference held recently at the Guildhall (Human Element, October 28), said: "Generally, the safe factory is the efficient factory and more often than not it is the one in which human relations are good." Sir Ewart Smith, deputy chairman of I.C.I., emphasised the contribution a lower accident rate can make to increased productivity. In his view, the problem of accident prevention needs the same analytical treatment as is provided by work study, in particular in planned maintenance. It is "an integral part of the drive for higher productivity, requiring the same emphasis on human values and effective leadership." Sir Walter and Sir Ewart were speaking in support of the Ro.S.P.A's Accident Prevention Week; other speakers, Mr. A. E. Amor, deputy managing director of Kodak, Limited, and Mr. P. E. Trench, managing director of Bovis, Limited, dealt respectively with the effect of accidents on the manpower situation and with accident prevention in the building industry.

The statistics given to the meeting could not fail to impress: nearly 20 million man-days are lost every year through industrial injuries or through illness caused by occupational diseases. On any one day 60,000 people are absent from work because of these things. The full cost is estimated at "much over £100 million a year." Mr. Amor pointed out that the elimination of the current accident rate of 3 per cent. could go far to relieve the nation's shortage of labour, which he estimated at 2 per cent. Such statistics are disturbing, and they were meant to be. Good management, good leadership and good industrial housekeeping cannot come overnight, but the simplicity of the Society's recommendations are significant.

* * *

Engineering Pay Claim Manoeuvres

A claim for substantially higher wages was submitted by the Confederation of Shipbuilding and Engineering Unions back in August. Last week, the two sides met together formally for the first time since that date. In August, the unions had in mind to ask for an increase of 10 per cent. Since the autumn Budget, there have been rumours that they would raise their demand to 15 per cent. because they expected the Budget to increase the cost of living. If in due course the demand crystallises at 15 per cent. it will be the largest single wage demand ever put up in British industrial history. It will involve about £100 million a year.

Last week, matters were not taken very much further. The union reiterated that they wanted a substantial increase but they did not mention a specific figure. This was thought to have been due to the fact that they could not decide among themselves whether to pitch their demand at 10 or 15 per cent. On the employers' side, they have intimated that they would consider the claim and meet the Confederation again as soon as possible, which is likely to be sometime next month. Meanwhile it will consult with its member associations. On the union side, the interval will presumably be occupied in watching the effect of the Budget proposals on the cost of living to enable it to decide what the specific demand shall be.

* * *

Social Problems of Automation

There is a broad movement afoot to break down the idea that automation is a "horrible robot." The trade union point of view was put forward by Mr. J. Williams in the November issue of the T. and G.W. Record: can we (trade unionists) prevent British industry from benefitting from the higher productivity that the adoption of automatic transfer techniques make possible? Not if we are to compete in world markets. "It is our job as a movement to see that automation does not give us mass unemployment. We can prevent this, but we cannot prevent the unemployment that is caused by inefficient industry, unless of course we accept a declining standard of living." The official leadership of the trade unions is clearly of this opinion. They will insist that the benefits of higher productivity resulting from such major improvements in production techniques now taking place shall be widely shared. They are unwilling to obstruct the application of automatic techniques. Yet there is much genuine anxiety among the union rank and file, and those who preach anti-automation will get support unless a great deal more information is made available on the likely effects on machine minders and others on the shop floor.

The T.U.C. are conducting their own inquiry, and should have a lead to give their members before long (Labour Notes, August 12). Now the Institution of Production Engineers have taken a hand. They feel that, although the technical implications of automation are being fully studied, more attention should be given to its effects on the human being and on human relations in industry and in society. A committee has been formed under the chairmanship of Mr. A. F. Kelley, director and general manager of the aero-engine division of Rolls-Royce Limited, which includes such well-known public figures as Sir Leonard Lord, Sir Walter Puckey and Lord Halsbury. Two of their main objects are to explore the problem of increased leisure which is generally held to be the inevitable result of automation, and to consider the re-education necessary to secure the acceptance of automation by society. An admirable intent, but a tall order.

* * *

Parliament and the Call-Up

The debate on the Government's national service policy last week was preceded by a vigorous exchange on the subject of R.A.F. batmen serving in married quarters, whose duties included making beds, pressing ladies' clothes and taking children to school. It was alleged that the national service airmen concerned had received only eight weeks training during the whole of their service and no denial could be made when the question was pressed by Mr. Herbert Morrison.

When Mr. Selwyn Lloyd, Minister of Defence, opened the debate on the armed forces he said that a total strength of 700,000 was the lowest any Minister could advocate and that the reduction to this figure by March, 1958 (by 20 per cent.) made it essential for the men who were left to be as efficient as possible. The length of service would therefore be kept at two years.

The Opposition, led by Mr. R. R. Stokes, questioned the need for two years, contrasting it with the 18 months period served by most of the Allies and by the Germans, and called for a civil investigation of the forces' use of manpower. Mr. Bevan argued that since the civil authority was being asked to provide the men and the money, there was no reason why a select committee of the House should not be allowed to satisfy themselves that the men were being intelligently used, "because there was a grave suspicion that they were not so used." It is difficult to understand why the Government should so strenuously resist such an inquiry. This suspicion of misuse does exist, in industry as well as in Parliament. The decision to reduce the number of men called up (and therefore, by inference, to increase the number of exemptions) will please some employers; the decision to keep young men for two years will please the military leaders. But why not examine other possibilities?

* * *

Snobbish Attitude to Industry

At the closing session of the British Institute of Management conference at Harrogate last week, Mr. Graham Hutton told an audience of some 800 senior managers what he thought should be the objectives of good management. He considered that the reason why Britain had fallen behind in the race for the highest material standard of welfare was because of the nation wide snobbish attitude to business, production management, administration, etc. His three objectives of good management were: installing new capital equipment and making it work to capacity; planning new applications of science in machinery and methods and then planning the application of them to men, materials and machines; and, finally, working out a nation-wide revolution in attitudes to business and work.

One suspects that old-fashioned snobbery about business is a dying vice. Those who are socially powerful and those who are influential in the professions are mostly glad enough to-day to take the rewards which industry and trade can offer. Intellectually, the universities are less aloof from business than they were formerly. Snobbery as an active deterrent to business enterprise to-day probably acts mainly through indifference: in some circles, perhaps, it is not the done thing to exert oneself to maximise profits. Average profits, absence of competition so that everyone gets a cut of what turnover there is, a wish to preserve capital rather than increase it, and the burden of income tax which operates to encourage those who are inclined to an easy-going attitude, are among the forces at work to limit enterprise. These can be forms of snobbery, but they are not the same sort of thing as the snobbery of grandfather's, and to a less extent, father's day.